NCDOT Digital Imagery Distress Evaluation Handbook

Version 1.0

North Carolina Department of Transportation
Pavement Management Unit

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Questions or Comments?
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Special thanks to the Virginia Department of Transportation Maintenance Division. This manual is heavily based on their work. The majority of the drawings and photographs were provided by VDOT. They will be gradually replaced with NCDOT specific imagery over time.

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Introduction

The North Carolina Pavement Management System makes use of pavement condition data to analyze and prioritize pavement maintenance and rehabilitation projects, to predict pavement performance, and to develop optimum strategies for the future maintenance and rehabilitation of pavements on the state highway network. Since 1982, pavement condition data has been collected using windshield surveys. These surveys involve driving at slow speeds along the road or shoulder of the road and noting distress data on pre-printed forms. Windshield surveys are not without issues – subjectivity is high and increases as the number of raters increases, and this reduces repeatability. In addition, safety is an issue on high volume, high speed routes.

High speed image collection has been available for many years and recent advances in technology have pushed NCDOT to look at incorporating its use into Pavement Management processes. Beginning in the fall of 2011, interstate and primary condition surveys will be conducted using high speed digital imagery and automated and/or semi-automated data processing.

This manual has been adapted from the Virginia Department of Transportation version and is focused on data collection through digital images and associated post-processing.

As with any contracted service, certain standards are required for bidding purposes and to manage the work as it progresses. A major purpose of this manual is to provide those standards through clear definitions of pavement distresses as well as clear statements of how distress data are to be collected and how those distresses are to be evaluated by both contractors and state personnel. As much as possible, definitions and data collection and evaluation procedures are compatible with the Strategic Highway Research Program (SHRP) Long Term Pavement Performance (LTPP) Distress Identification Manual (1) and with the HPMS Field Data guide.

Pavement distress data in North Carolina is used to determine pavement condition index values which in turn are used to make pavement management, maintenance and rehabilitation estimations. Moving to a process using digital images will provide a more repeatable, more complete evaluation of distress on the interstate and primary systems. The use of a web-based system to distribute the collected data and imagery provides an entirely new tool for NCDOT end users putting more data at their fingertips.

1.0 General Requirements

1.1 General Data Collection Requirements

Equipment requirements: Distance measuring, laser, and imaging equipment shall meet the specifications, calibration requirements, and quality control requirements as specified in this document and in the contract agreement between NCDOT and the selected vendor. For distress evaluation purposes a major requirement is that digital images be of sufficient resolution to identify cracking of 1/8 inch width in the downward perspective and ¼ inch width in the forward perspective when traveling at survey speeds.

Portion of the pavement to be imaged: Cover the full pavement surface of the rightmost (travel) lane with downward digital images covering a width of 14 feet. PCC pavements will typically have well defined longitudinal joints at both edges. Lane width will typically be 10-12 ft. and will be captured in the images. Right of way images are required for both the left and right edges of the roadway. A camera or cameras capable of collecting the left and right shoulders shall be used.

Roadway Travel Impediments: When roadway impediments force the survey vehicle to leave the normal travel lane the operators shall make note of the exception. In such cases, the "lane" field of the database shall be coded appropriately with the lanes numbered from right to left in the direction of travel.

Weather Restrictions: Pavement images are not collected during rain, snow, or under other conditions contributing to poor pavement visibility.

1.2 Distress Evaluation Information

Distress Evaluation Summary Tables: In addition to the detailed procedures outline in the document, tables summarizing the distress evaluation procedures are grouped in Appendix A.

Definitions: A glossary of most pavement terms used in this manual is included as Appendix B.

Data Delivery Tables: Appendix C contains the data delivery tables and formats for Asphalt, Jointed Concrete (JCP), Continuously Reinforced Concrete (CRC), and shoulder distress ratings.

1.3 General Distress Evaluation Rules

The following rules are applicable to all types of pavement and are intended to ensure good quality evaluations of all distresses visible on the digital images and of all parameters measured by lasers.

1. Rate the full width of the lane represented on the computer monitors. On roadways with visible pavement, rate from the inside edges of the pavement stripes. On roadways with no visible striping, rate a 10 foot width of pavement beginning at the right edge.

2. Skip portions of the images falling on bridge approach slabs and bridge decks. The forward view camera will provide a means of determining when exceptions are being approached.

3. It is often necessary to review distressed areas several times in order to correctly characterize pavement condition.

4. Most distresses will be rated according to one of three levels of severity: low, moderate or high. Some distresses will only be rated at two levels. In such cases, only low and moderate severity will be used. The extent of distress for each type is determined as described under the distress evaluation and will be quantified in terms of linear feet, square feet or other quantity as applicable.

5. As a *general* quality control check, the total length of longitudinally measured distress of all severity levels should not normally exceed the length of pavement surveyed. For example, if 1000 linear feet of pavement is evaluated there can be no more than 1000 linear feet of cracking in the right wheel path and 1000 linear feet in the left wheel path. If this *general rule* is routinely broken, there is quite likely a problem with the data.

6. Raters should be especially cautious about rating pavement distresses or maintenance activities where the color change between the pavement and the feature is so subtle that the feature is hard to see in the pavement (downward) view, but may be visible in the forward view. Examples are skin patching and bleeding of flexible pavements and full width repairs of rigid pavements. Such features sometimes indicate serious hidden distress so their detection is important to proper pavement evaluation. For this reason *the proper evaluation process requires that the rater makes one pass through the forward perspective view prior to the detailed evaluation.* During this initial pass the rater should note the presence and approximate locations of “hidden” features so they will not be missed in the detailed rating.

7. Overlays of jointed or continuously reinforced concrete pavements are considered asphalt surfaced pavements and classified as composite pavements. Therefore, these overlaid pavements should be rated following the process and definitions from asphalt concrete distresses in Chapter 2 with the exception of the unique distresses discussed in Chapter 3 for bituminous over Portland Cement Concrete.

2.0 Rating Asphalt and Composite Pavements

2.1 General Asphalt Rating Guidelines

1. Rate the pavement continuously as the images progress. On some pavements, especially in moderately distressed conditions, it may be necessary to review portions of the pavement several times as it may be impossible to capture all features in one pass.

2. Continue the rating process through utility patches as if the patch did not exist. Do not count the edges as cracks. Also make sure that distress within the patch is NOT rated separately from the patch.

3. Assume there is cracking under all crack sealant and rate accordingly.

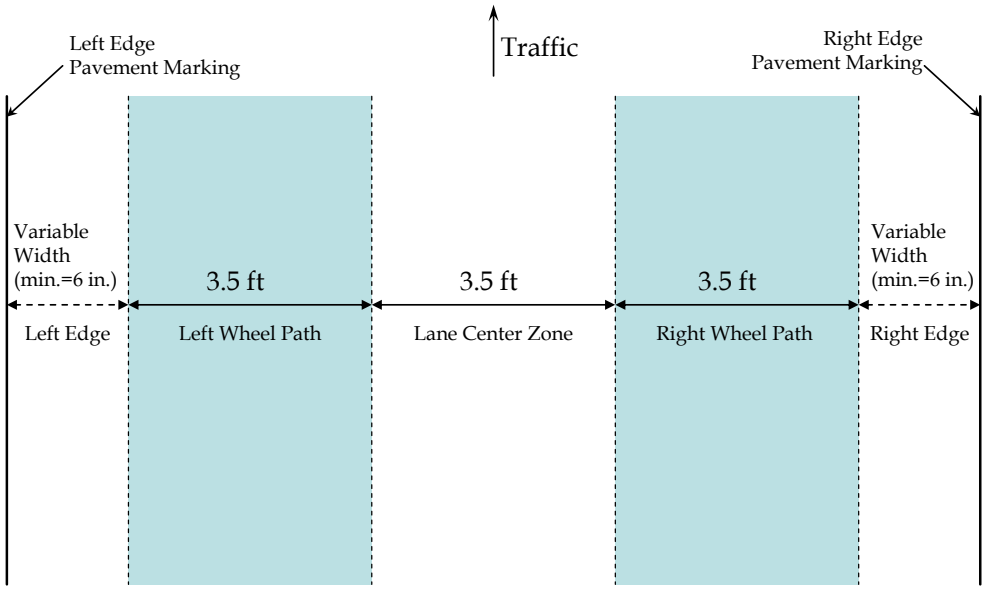
4. ***Open/Closed Cracks:*** In many cases the instructions refer to *open* or *closed* cracks. In those cases, the rater may use ¼ inch as the guide criteria. Cracks judged to be equal to or less than ¼ inch wide would be considered closed" and those more than ¼ inch wide would be considered "open".

5. In other cases, the terminology "significant" is used with reference to the length of crack effected, etc. In such cases, *¼ of the crack length (25%)* is defined as a significant portion of the length.

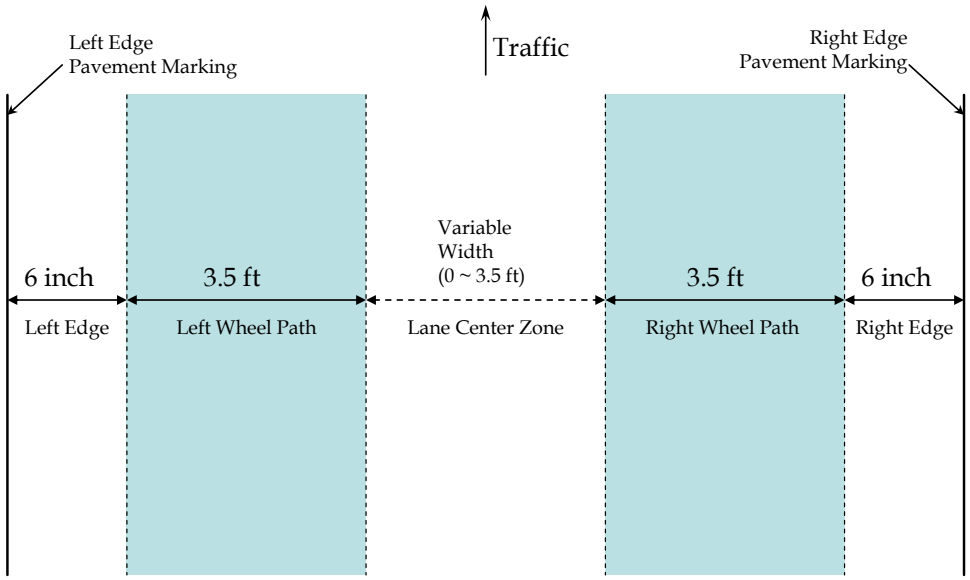
6. The classification of several distresses depends upon the location within the roadway of that distress, that is, whether the distress falls within the wheel path or outside of the wheel path. For this reason, NCDOT has identified the road-zones as illustrated below. Each wheel path should always be 3.5 feet wide. The minimum edge width should be 6 inches but it can be larger. The maximum lane center width is 3.5 feet. For roads with narrower lanes the lane center is the variable and should be adjusted depending on the width of the lane. When the lane exceeds 11.5 feet, the edge widths will be greater than 6 inches.

The pavement to be included in the ratings is the area between the pavement stripes. Any cracking or other distresses that fall in or beyond the pavement striping is not reported. Paving joints are only considered a distress when they are cracked or open. If a paving joint is visible but not opened up, then no distress is reported.

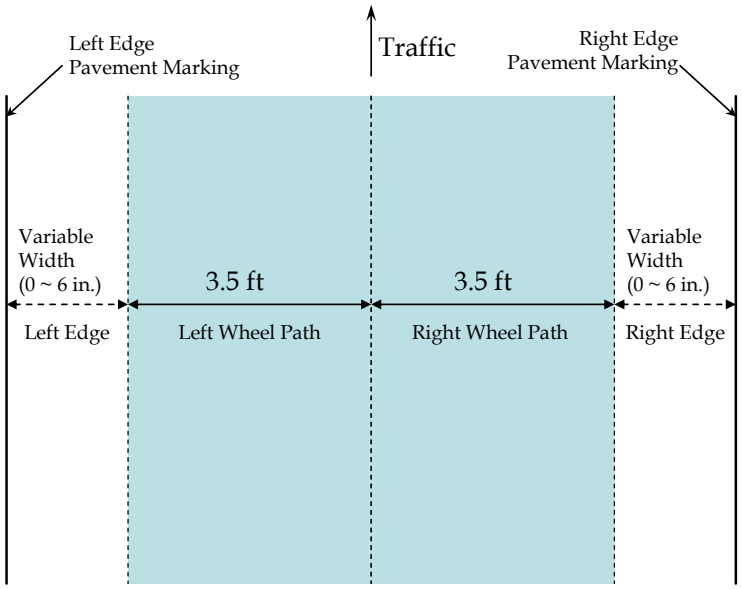
The following four figures define the location and size of the left and right wheel path as well as the center lane. Lane edges are defined as the inside edge of the pavement markings projected for the roadway. On roadways where no pavement markings exist, rate a 10 foot width of pavement, beginning at the right edge.



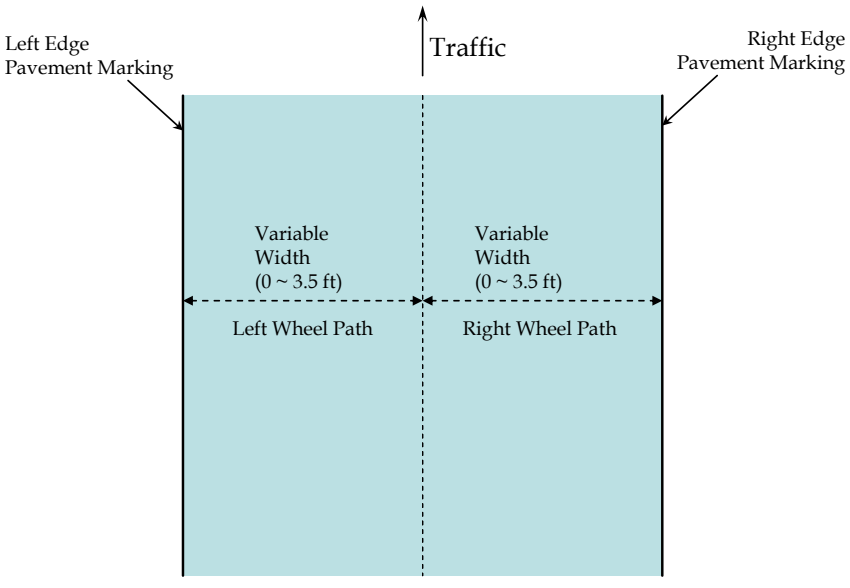
(1) Lane Width 12 ft or higher



(2) 8.0 ft ≤ Lane Width < 11.5 ft



(3) 7.0 ft ≤ Lane Width < 8.0 ft



(4) Lane Width < 7.0 ft

2.2 Transverse Cracking

Description

Transverse cracks are random cracks that run predominantly across the road (perpendicular to the pavement centerline), but not over the joints in an underlying jointed concrete pavement (see reflection crack evaluation in Chapter 3).

Severity Levels

Low Severity

- A sealed crack in good condition such that the crack width cannot be determined

  or

- A *closed* (crack width <1/4”), unsealed crack.

Moderate Severity

- An *open*, unsealed crack between ¼" and ½" in width,

  or

- Any crack (sealed or unsealed) with adjacent transverse cracking within 5-10 feet. Blocks of 10 square feet or larger may be present.

High Severity

- An *open*, unsealed crack > ½" in width

  or

- Any crack (sealed or unsealed) with adjacent transverse cracking within 5 feet . Frequent blocking is likely present with areas between 1 and 10 square feet.

Counting Transverse Cracking (linear feet)

1. The rater records length of transverse cracks at each severity level.
2. The pavement rater should evaluate each crack by highest severity level present on a significant portion of the crack as it is traversed.

Database Fields (Appendix C, Table 1)

- TRNSVRS_LOW_LF
- TRNSVRS_MDRT_LF
- TRNSVRS_HGH_LF

2.3 Longitudinal Cracking – Outside of the Wheel Paths

Description

Longitudinal cracks are those running predominately parallel to the centerline of the roadway, but not over joints in an underlying concrete pavement (see joint reflection cracking in Chapter 3). However, for rating purposes, only longitudinal cracks outside the wheel paths are counted as longitudinal. Those inside the wheel paths are counted low severity alligator cracks (see below)

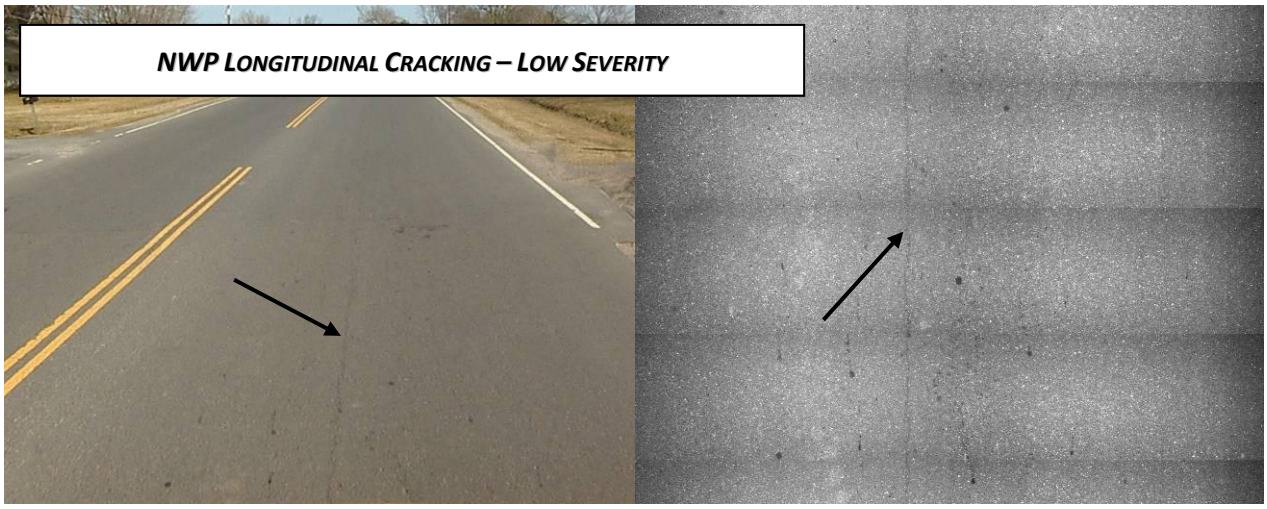
Severity Levels

Low Severity

- A crack with the sealant in good condition such that the crack width cannot be estimated

  or

- A *closed* (crack width <1/4”), unsealed crack.

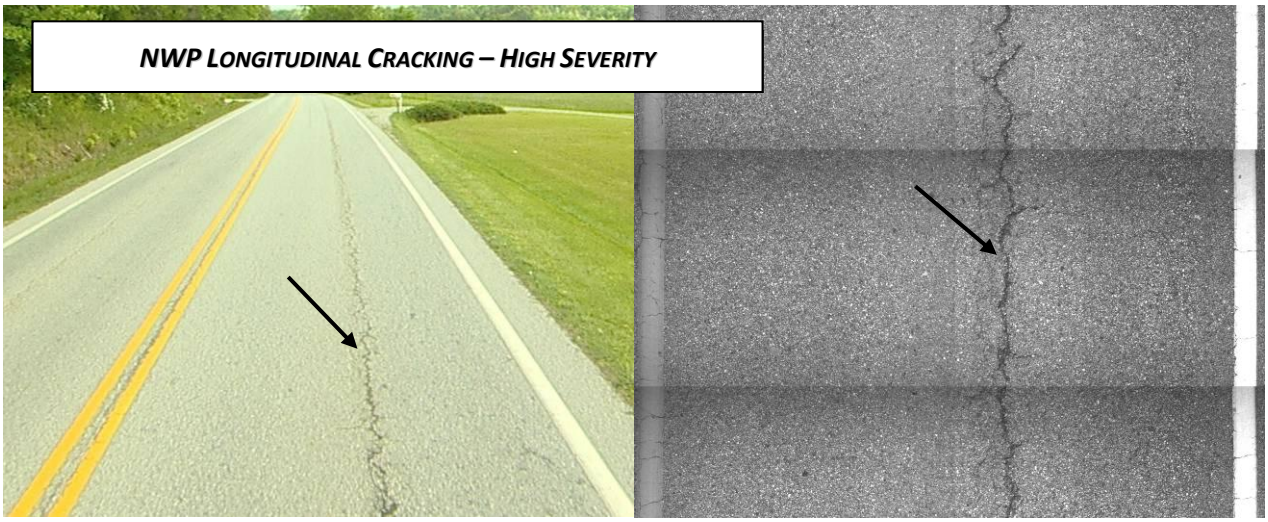


High Severity

- An *open*, unsealed crack,

  or

- Any crack (sealed or unsealed) with adjacent random cracking.



Counting Non-Wheel Path Longitudinal Cracking (linear feet)

1. The minimum length of longitudinal cracking counted is 1 foot.
2. Only longitudinal cracking outside the wheel paths is counted and each occurrence is counted separately.
3. Longitudinal cracking in the wheel paths is counted as Low Severity alligator cracking and should not be included in this rating.
4. The pavement rater should measure the length of each crack by severity level as it is traversed. Rate each crack at the highest severity level present on a significant portion of the crack.
5. The rater reports the total length of cracking by severity level for the section.

Database Fields (Appendix C, Table 1)

- LNGTDNL_LOW_LF
- LNGTDNL_HGH_LF

2.4 Longitudinal Lane Joint Cracking

Description

The rater is cautioned to evaluate longitudinal paving joints (typically near the edges of the lane) with extreme caution. A longitudinal paving joint is only classified as a distress when the joint has cracked and will allow water to penetrate the joint.

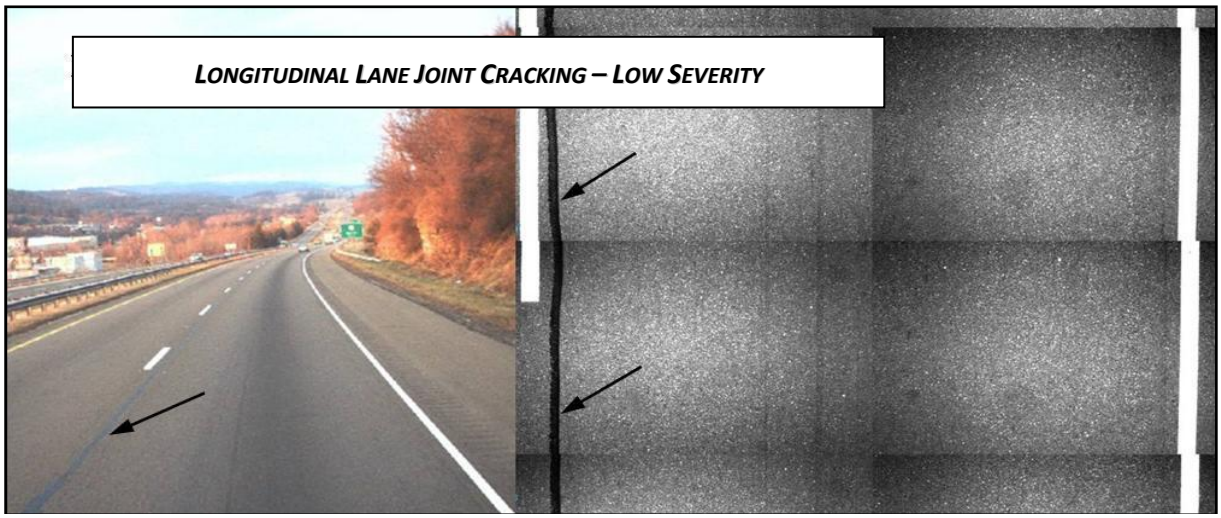
Severity Levels

Low Severity

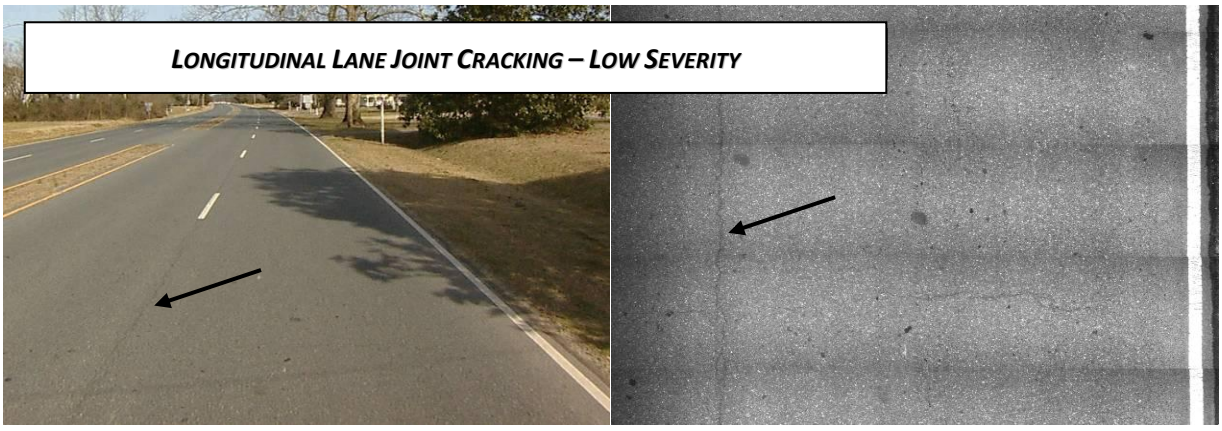
- A longitudinal paving joint with the sealant in good condition such that the width cannot be estimated,

  or

- An open, unsealed joint.



LONGITUDINAL LANE JOINT CRACKING – LOW SEVERITY



LONGITUDINAL LANE JOINT CRACKING – LOW SEVERITY

High Severity

- The longitudinal paving joint must be cracked with severe spalling or adjacent random cracking to be classified as high severity.

Counting Lane Joint Cracking (linear feet)

1. The minimum length of longitudinal lane joint cracking counted is 1 foot.
2. The pavement rater should measure the length of each crack by severity level as it is traversed.
3. Rate each crack at the highest severity level present on a significant portion of the crack.
4. The rater reports the total length of cracking by severity level for the section.

Database Fields (Appendix C, Table 1)

- LNGTDNL_LANE_JNT_LOW_LF
- LNGTDNL_LANE_JNT_HGH_LF

2.5 Alligator (Fatigue) Cracking

Description

Alligator cracking, often referred to as fatigue cracking, occurs in areas subjected to repetitive wheel loads and for rating purposes is only found in the wheel paths. Alligator cracking typically begins as longitudinal cracking in the wheel paths which develops over time to a series of interconnected cracks having a chicken wire or "alligator hide" pattern.

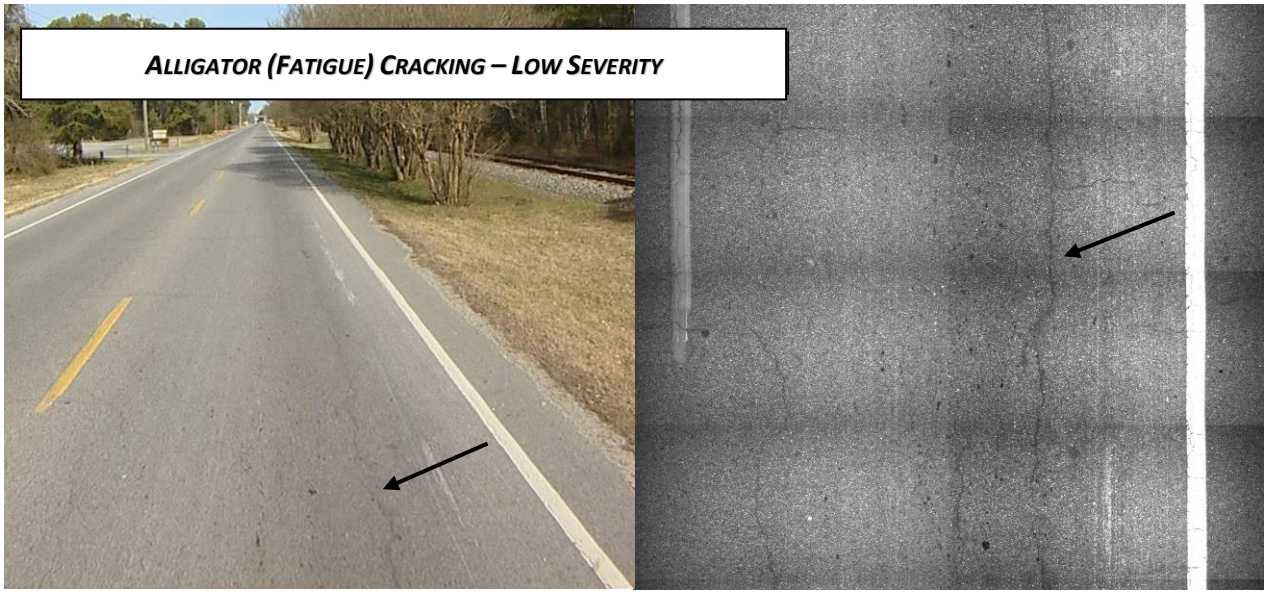
Severity Levels

Low Severity

- A single sealed or unsealed longitudinal crack in the wheel path,

  or

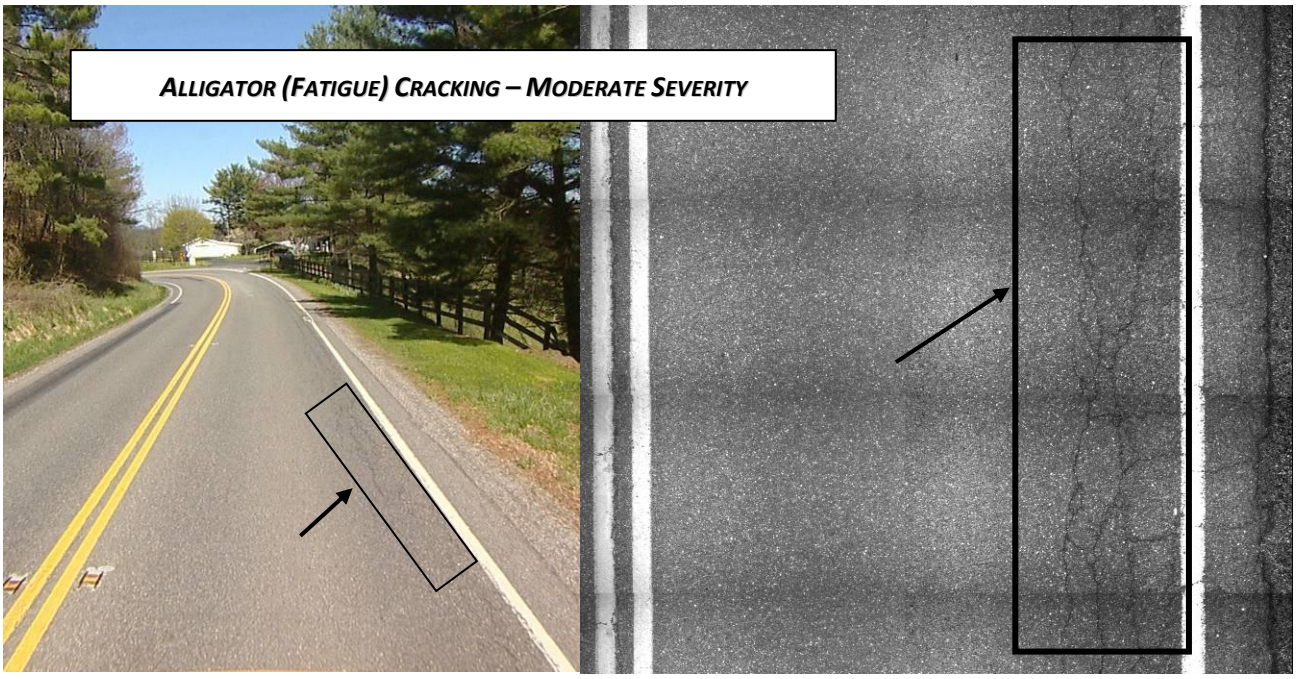
- An area of cracks with no or few interconnecting cracks with no spalling. Cracks are typically 1/8” or less wide.



ALLIGATOR (FATIGUE) CRACKING – LOW SEVERITY

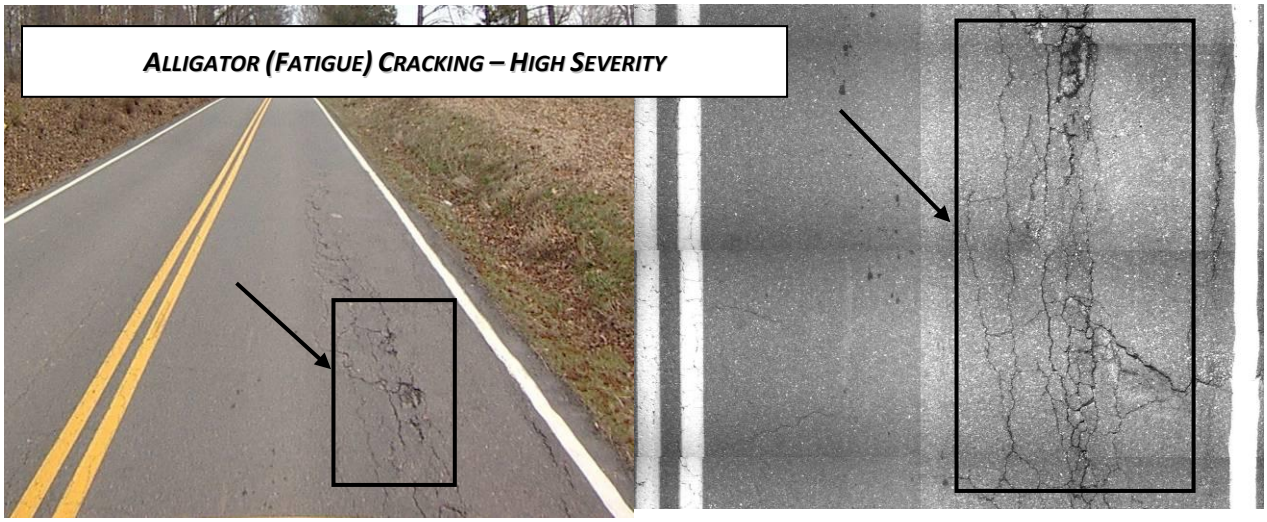
Moderate Severity

- An area of interconnecting cracks forming the characteristic alligator pattern; may have slight spalling. Cracks are typically about ¼" wide.



High Severity

- An area of moderately or severely spalled cracks forming the characteristic alligator pattern. Cracks are typically greater than 3/8" wide.



Counting Alligator Cracking (square feet)

1. Considering only the left and right wheel paths, measure the affected area (square feet) at each severity level.
2. Consider only one severity level for a given area. If different severity levels in an area cannot be distinguished, rate the area at the highest severity level.
3. The width of alligator cracking shall be the actual width while a minimum width for all severity levels shall be 1 foot. Report the square feet of alligator cracking by severity level for the section.

Database Fields (Appendix C, Table 1)

- ALGTR_LOW_SF
- ALGTR_MDRT_SF
- ALGTR_HGH_SF

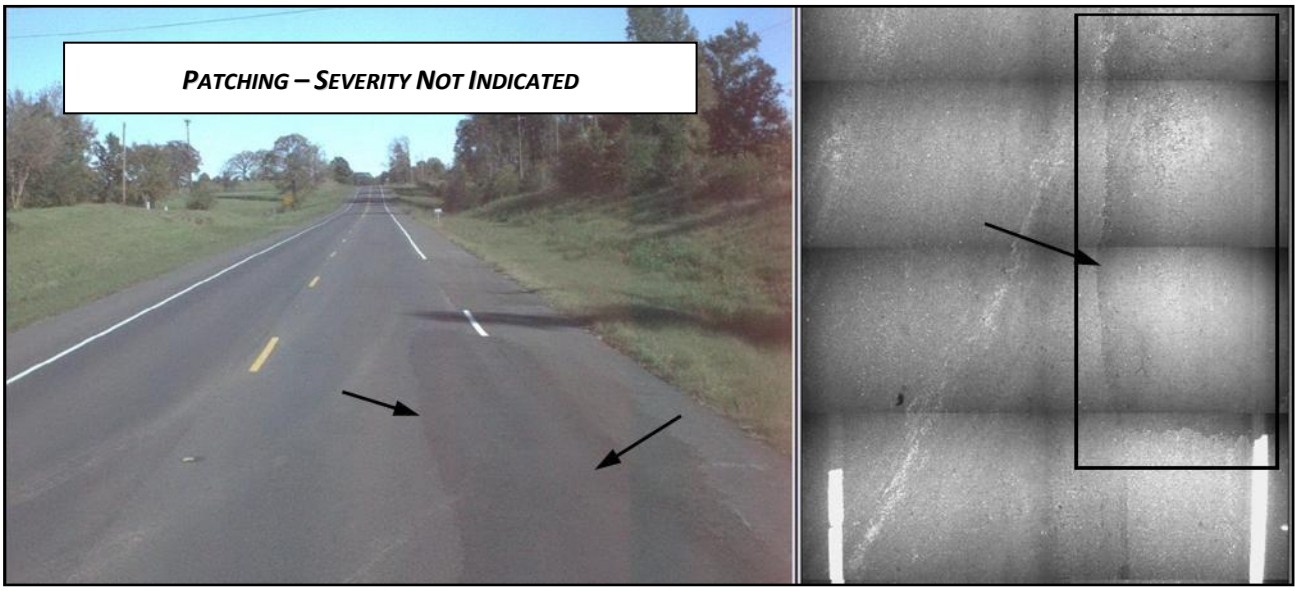
2.6 Patching

Description

Patches are areas of the pavement surface that have been removed and replaced or where additional material has been placed on the pavement surface to cover cracking or other distress. Wheel path and non-wheel path patching is to be counted separately.

Severity Levels

- Patching does not have a severity level, only an amount.



Counting Patching (square feet)

1. Patches with a longest dimension of less than 6 inches are not counted.
2. If a patch is full-lane width, the maximum size is 0.25 miles, otherwise (i.e. not full lane width), there is no maximum size.
3. The rater should measure area of the patch.
4. The patches shall be reported in square feet of patching for the area in the wheel path and square feet of patching for the area out of the wheel path.

Database Fields (Appendix C, Table 1)

- WP_PTCH_SF
- NWP_PTCH_SF

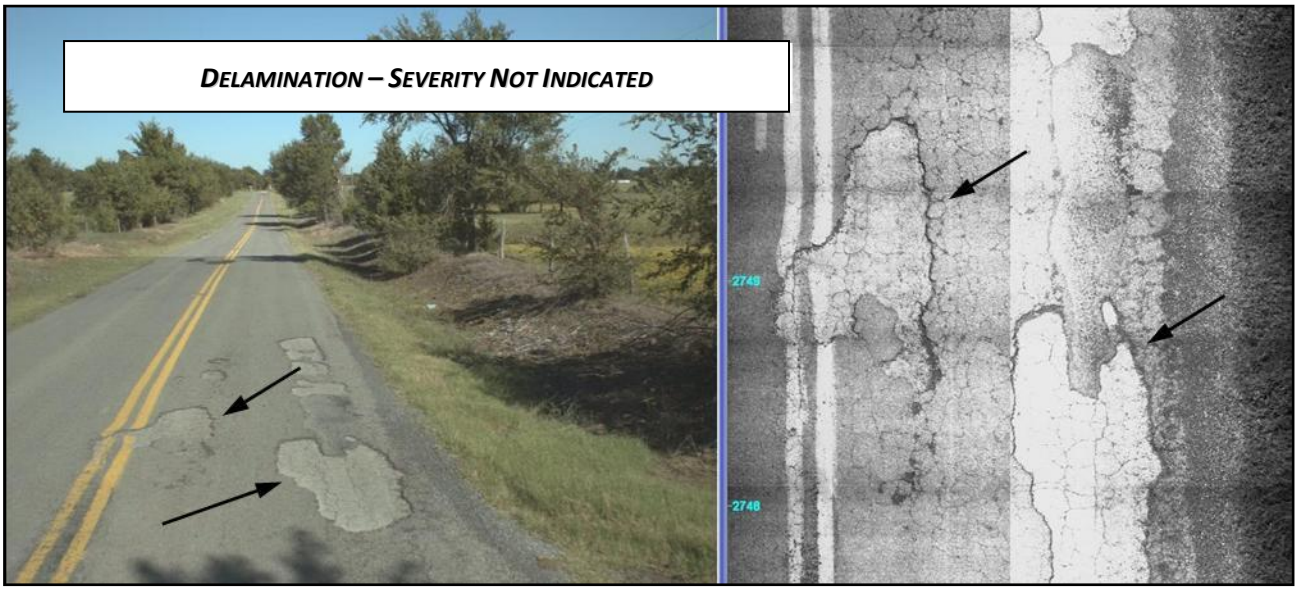
2.7 Delamination

Description

A delamination is an area of pavement surface missing due to the loss of adhesion between the surface and underlying layers. Delaminations typically are one layer thick, i.e. the thickness of the surface course. They may range from one-foot square to hundreds of square feet in extent and often occur in the wheel paths or along shoulders.

Severity Levels

- Delamination does not have a severity level, only an amount.



Counting Delamination (square feet)

1. Delaminations with a longest dimension of less than 6 inches are not counted.
2. The rater reports the square feet of delamination in a pavement section.

Database Field (Appendix C, Table 1)

- DLMN_SF

2.8 Bleeding

Description

Bleeding is the presence of excessive liquid bituminous material on the pavement surface. The surface may be shiny or glass-like and reflective. It may also be tacky to the touch, especially in warm weather. Bleeding is usually found in the wheel paths.

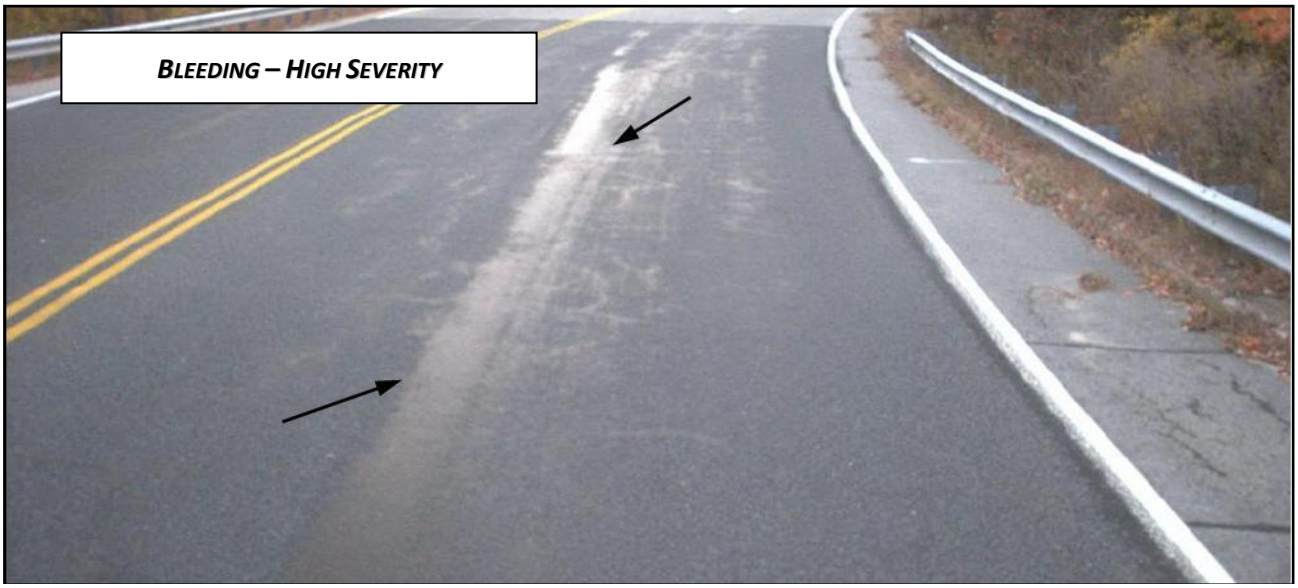
Severity Levels

Low Severity

- Pavement surface that is discolored relative to the remainder of the surface due to excessive liquid asphalt.

High Severity

- Excessive liquid asphalt gives the pavement surface a shiny appearance; tire marks may be evident in warm weather.



Counting Bleeding (Square feet)

1. For each severity level, record square feet of bleeding.
2. The rater is cautioned that it may be necessary to review images from a forward perspective view in order to detect the presence of bleeding, especially for low severity bleeding.

Database Fields (Appendix C, Table 1)

- BLD_LOW_SF
- BLD_HGH_SF

2.9 Rutting

Description

Rutting is the longitudinal surface depression in the wheel path. It may have associated transverse displacement. Rutting is collected using laser sensors which provide a transverse profile of the pavement surface. A minimum of twelve points are required to calculate the rut depths. Rut depths are calculated following the "straight edge" method as defined in ASTM E1703/E1703M-95(2005).

EXAMPLE OF RUTTING

Severity Levels

Severity levels are defined by the average rut depths reported for each 0.1 mile segment.

Severity None

- Less than 0.25 inches

Low Severity

- Greater than or equal to 0.25 inches but less than 0.50 inches

Moderate Severity

- Greater than or equal to 0.5 inches but less than 1.0 inch

High Severity

- Greater than 1.0 inch

Counting Rutting (Average depth for 0.1 mile)

1. The actual average depth of rutting is reported for the 0.1 mile section. The severity levels are informational.
2. The transverse profile is collected at prescribed intervals along the pavement.
3. The maximum left and right rut depths are then computed from these profiles using a six foot straight-edge process
4. The maximum rut depths, for the left and right wheel paths respectively, are then averaged over a 0.1 mile section. The deepest average for each calculation method is recorded. i.e., if the average rut depth for the right wheel path is greater, that value is recorded.

Database Fields (Appendix C, Table 1)

- MAX_RUT_AVG

2.10 Raveling

Description

Raveling is the wearing away of the pavement surface caused by the dislodging of aggregate particles or loss of asphalt binder. Raveling is much more common on chip seal or slurry surfaces than on plant mix surfaces and is sometimes noted on open graded friction course or ultra-thin bonded wearing course surfaces. Raveling indicates either a hardening or poor application of asphalt binder.

Severity Levels

Low Severity

- Aggregate loss within the pavement lanes is not great; small amounts of stripping may be detected; aggregate has started to wear away.

RAVELING – LOW SEVERITY

Moderate Severity

- Some stripping evident; random stripping with small areas (less than one square foot) or strips of aggregate broken away.

High Severity

- Stripping very evident; aggregate accumulation may be a problem, particularly along the shoulders; large sections (greater than one square foot) of stripping with aggregate layer broken away.

Counting Raveling (Square Feet)

1. For each severity level, record square feet of raveling.
2. The rater is cautioned that it may be necessary to review images from a forward perspective view in order to detect the presence of raveling, especially for severity level 1.

Database Fields (Appendix C, Table 1)

- RVL_LOW_SF
- RVL_MDRT_SF
- RVL_HGH_SF

2.11 Summary of Asphalt Distresses

A summary of asphalt concrete distress rating procedures is given in Appendix A, Table 1.

3.0 Rating Composite Pavement Distresses

3.1 General Information on Composite Pavements

An asphalt overlay of a Portland Cement Concrete pavement is a special class of asphalt concrete surfaced pavement. In the case of an asphalt overlay over a jointed concrete pavement, the distinguishing feature is typically uniformly spaced, straight transverse reflection cracks over transverse joints in the underlying JCP. In North Carolina, some asphalt may be placed over concrete pavement with joints that are spaced at varying intervals. Similar straight longitudinal reflection cracks may occur over the longitudinal joints in the PCC pavement. In the case of an asphalt overlay over a continuously reinforced concrete pavement, the distinguishing feature is straight longitudinal reflection cracks over the longitudinal joints.

Reflection cracks also occur over "working" transverse cracks in JCP or CRC pavements.

This chapter is focused on proper rating of reflective cracking. Other than this special case, composite pavements are rated using the guidelines specified in Chapter 2. Attempts have been made to properly classify composite pavements; however, if the data collection vendor suspects that a pavement is composite when it has not been labeled as such, the Pavement Management Unit should be notified so that further research can be conducted.

3.2 Transverse and Longitudinal Reflection Cracking over Joints in Composite Pavements.

Description

Reflection cracks in asphalt concrete overlays of PCC pavements occur over joints in that underlying pavement. In the absence of an accurate pavement history, the presence of uniformly spaced, straight, transverse cracks are an indicator of an underlying jointed PCC pavement. As with other asphalt concrete pavements, the rater may use a width of ¼ inch as the dividing line between *closed* and *open* cracks. In addition, for this type of pavement, a third severity level comprised of the deterioration of the joint being reflected through to the surface exhibited by multiple cracks or an area of random cracking is defined. Transverse reflection cracks in asphalt concrete overlays of PCC pavements (i.e., composite) occur over joints of the underlying pavement. *All the cracks appearing due to the movement at one joint should be reported as a single reflective crack.*

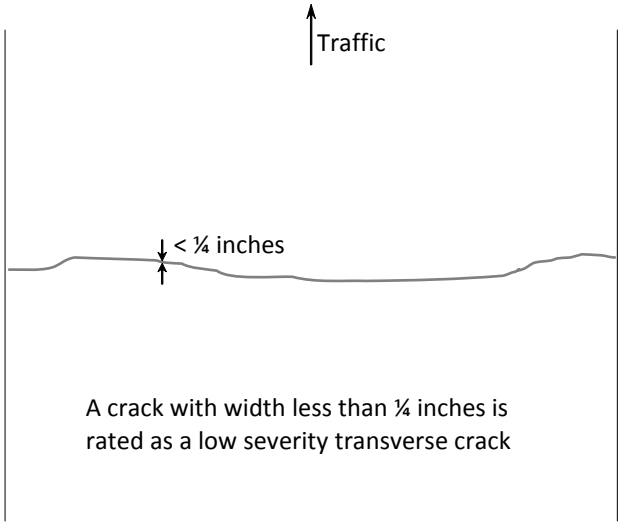
Severity Levels

Low Severity

- A crack with the sealant in good condition such that the crack width cannot be determined,

or

- A closed, unsealed crack.



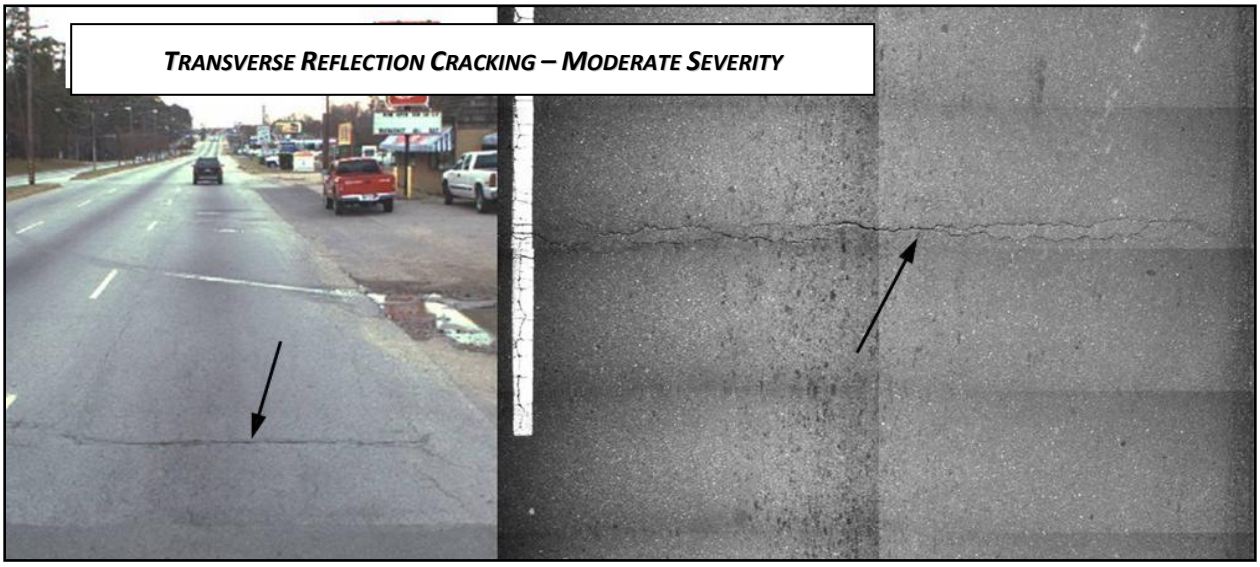
Moderate Severity

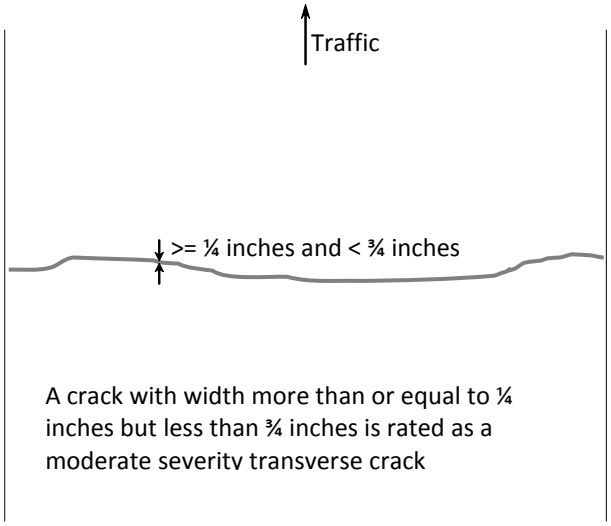
- A crack with width more than or equal to ¼ inches but less than ¾ inches;

  or

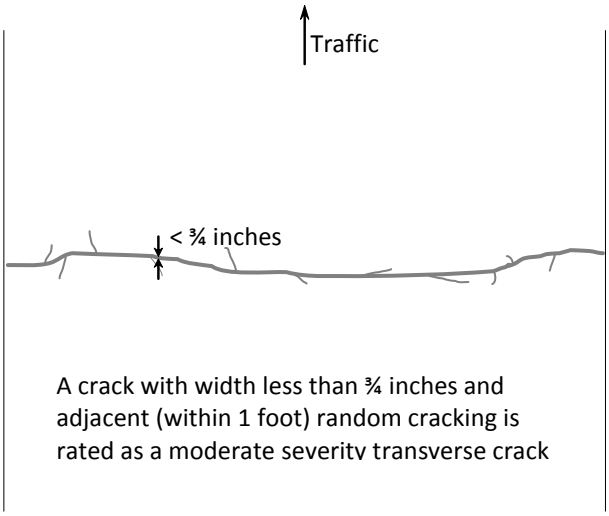
- A crack with width less than ¾ inches and with adjacent (within 1 foot) random cracking;

- One low or moderate severity crack with an adjacent (within 1 foot) low severity crack is rated as one crack of moderate severity.

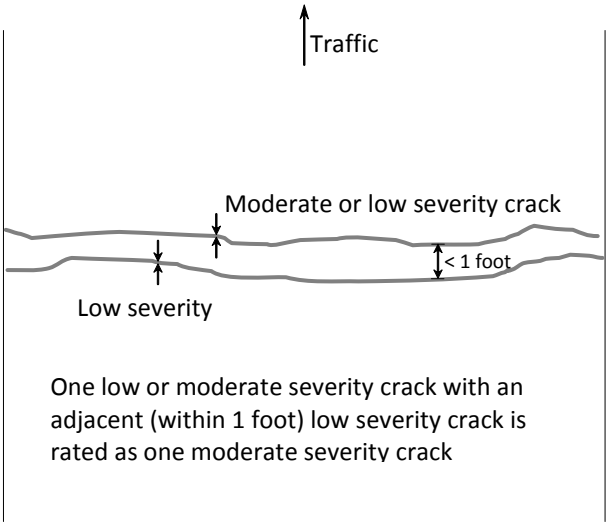




A crack with width more than or equal to ¼ inches but less than ¾ inches is rated as a moderate severity transverse crack



A crack with width less than ¾ inches and adjacent (within 1 foot) random cracking is rated as a moderate severity transverse crack



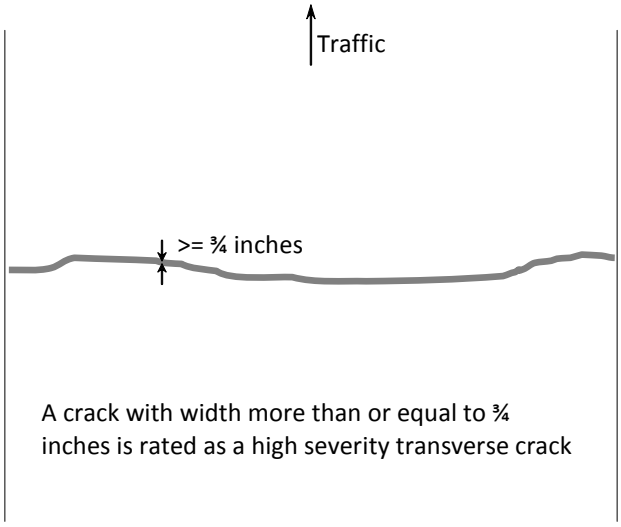
One low or moderate severity crack with an adjacent (within 1 foot) low severity crack is rated as one moderate severity crack

High Severity

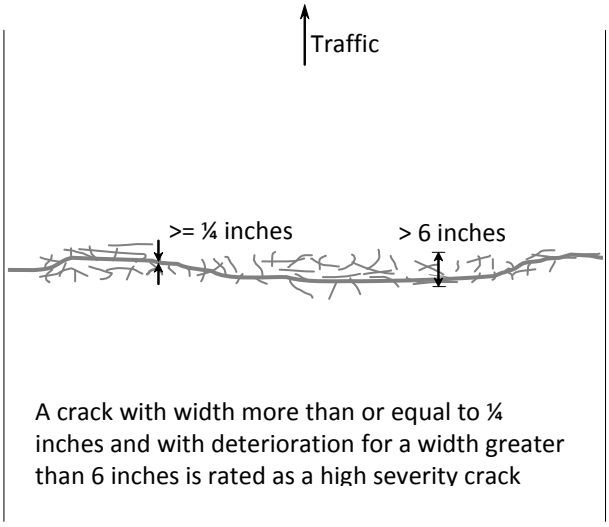
- A crack with width more than or equal to ¾ inches;

or

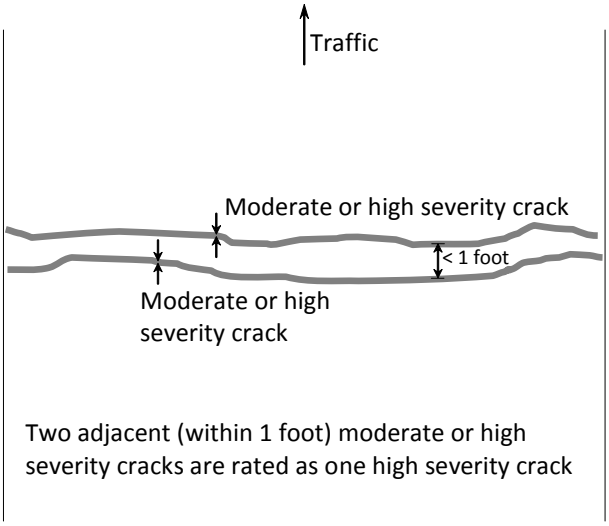
- A crack with width more than ¼ inches and with deterioration for a width greater than 6 inches;
- Two adjacent (within 1 foot) moderate and/or high severity cracks are rated as one crack of high severity.



A crack with width more than or equal to ¾ inches is rated as a high severity transverse crack



A crack with width more than or equal to ¼ inches and with deterioration for a width greater than 6 inches is rated as a high severity crack



Counting Reflection Cracking

Transverse Reflection Cracking

1. The rater records length of transverse cracks at each severity level.
2. Only one transverse crack is reported for each underlying joint.
3. Evaluate each crack by highest severity level present on a significant portion of the crack as it is traversed.

Longitudinal Reflection Cracking

1. The minimum length of longitudinal cracking counted is 1 foot.
2. Only longitudinal cracking outside the wheel paths is counted as longitudinal and each occurrence is counted separately.
3. Longitudinal cracking in the wheel paths is counted as Low Severity alligator cracking.
4. Measure the length of each crack by severity level as it is traversed.
5. Rate each crack at the highest severity level present on a significant portion of the crack.
6. The rater reports the total length of cracking by severity level for the section.

Database Fields (Appendix C, Table 1)

- RFLCT_TRNSVRS_LOW_LF
- RFLCT_TRNSVRS_MDRT_LF
- RFLCT_TRNSVRS_HIGH_LF

- RFLCT_LNGTDNL_LOW_LF
- RFLCT_LNGTDNL_MDRT_LF
- RFLCT_LNGTDNL_HGH_LF

3.3 Other Distress in Asphalt Overlays of PCC Pavements

Most distresses other than reflection cracking, normally occurring in overlays of PCC pavements, also occur in other asphalt concrete pavements. Raters are referred to Chapter 2 for the procedures to use in rating those distresses.

3.4 Summary

A summary of distress rating procedures for asphalt concrete overlays of PCC pavement that are in addition to those in Table 1 are given in Appendix A, Table 2.

4.0 Rating Jointed Concrete Pavement (JCP)

4.1 General JCP Rating Guidelines

1. Being careful to capture all the distresses visible on the images, rate the pavement, slab by slab as the images progress. On some pavements, especially in moderately distressed conditions, it may be necessary to review portions of the pavement several times as it may be impossible to capture all features in one pass.

2. For jointed PCC pavements, the number of slabs affected by each distress type is typically what is important. For those purposes, full-width repairs greater than 6 feet in length are considered as separate slabs.

3. It is necessary to count the total number of joints in the section. The joints at all full-width greater than six feet long repairs are counted as additional joints.

4. In many cases the instructions refer to "open" or closed" cracks. In those cases, the rater may use as guide criteria a crack width of ¼ inch. Then, cracks judged to be equal to or less than ¼ inch wide would be considered "closed" and those greater than ¼ inch wide would be considered "open".

4.2 Corner Breaks

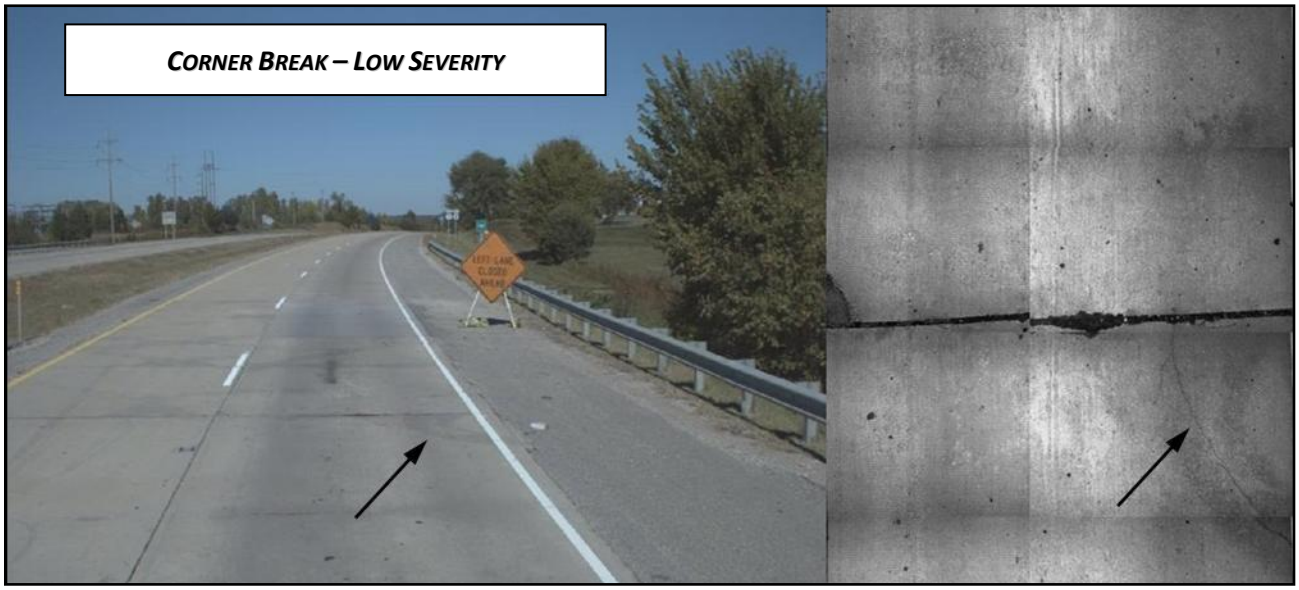
Description

A corner break is a portion of the slab separated by a crack, which intersects the transverse joint at one end of the slab and the longitudinal joint on one side of the slab and having a minimum dimension greater than six (6) inches. The crack makes approximately a 45° angle with the direction of travel.

Severity Levels

Low Severity

- The crack is spalled for no more than 1/4 of its length and the corner break is in one piece.

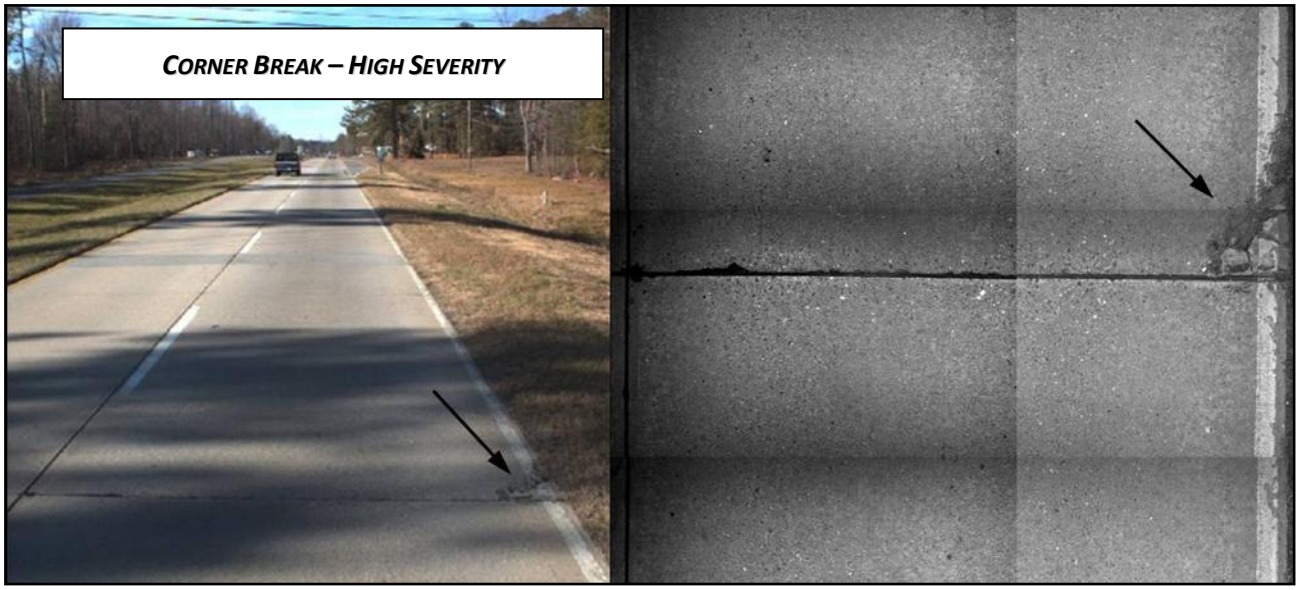


High Severity

- The crack is spalled for more than 1/4 of its length,

or

- The corner break is in two or more pieces.



Counting Corner Breaks (Number of slabs)

1. Count the number of slabs containing one or more corner break(s).
2. For two or more corner breaks, the highest level of severity should be recorded.
3. A slab containing both low and high severity corner breaks would be counted as one slab containing a high severity corner break.

Database Fields (Appendix C, Table 2)

- CRNR_LOW_NBR
- CRNR_HGH_NBR

4.3 Joint Seal Condition

Description

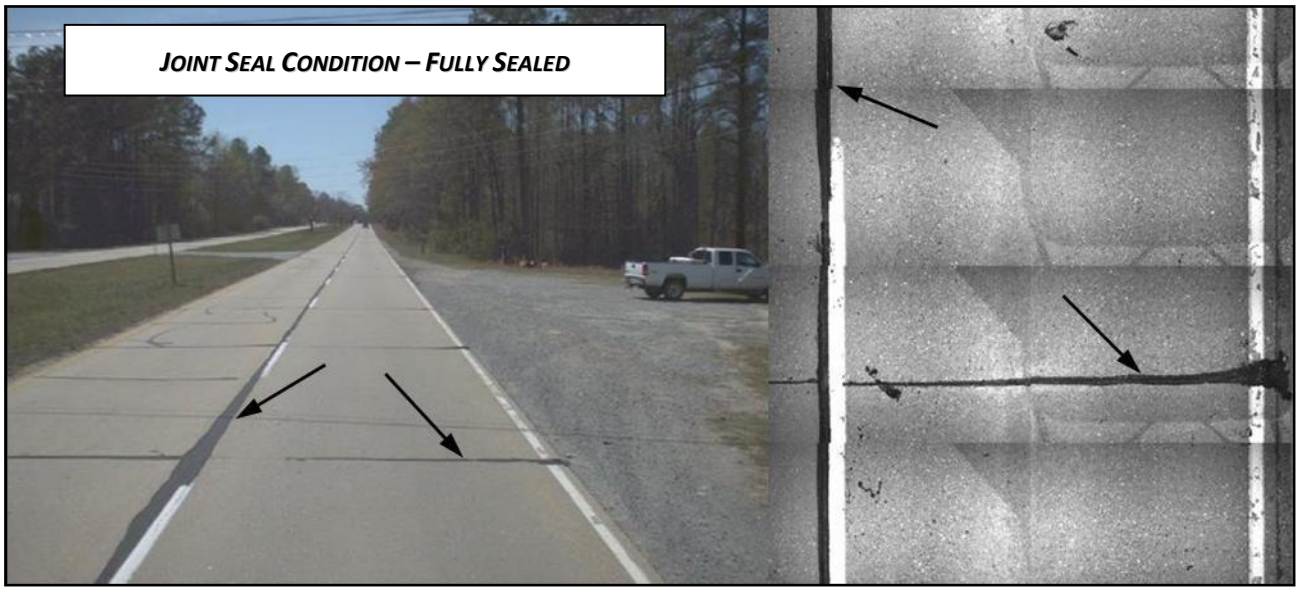
A joint seal is considered to be damaged whenever the seal will permit the infiltration of water and incompressible materials from the surface. A sealed joint is defined as one that appears from the image to be capable of resisting the infiltration of surface water. For the purposes of rating seal condition from images, joints are considered to be either fully sealed or unsealed, i.e. if any portion of the joint appears to be unsealed the entire joint is considered to be unsealed.

Counting Transverse Joint Seal Condition

1. Record the number of transverse joints which are fully sealed in the section.

Counting Longitudinal Joint Seal Condition

1. Record the number of slabs having fully sealed longitudinal joints in the section.
2. For seal evaluation purposes, assess segments of longitudinal joints between transverse joints and classify each segment as either fully sealed or unsealed.



Database Fields (Appendix C, Table 2)

- TRNSVRS_JNT_SEAL_NBR
- LNGTDNL_JNT_SEAL_NBR

4.4 Spalling – Transverse Joints

Description

Breaking or chipping of slab edges along and within two feet of a transverse joint. Spalls may be filled with asphalt concrete.

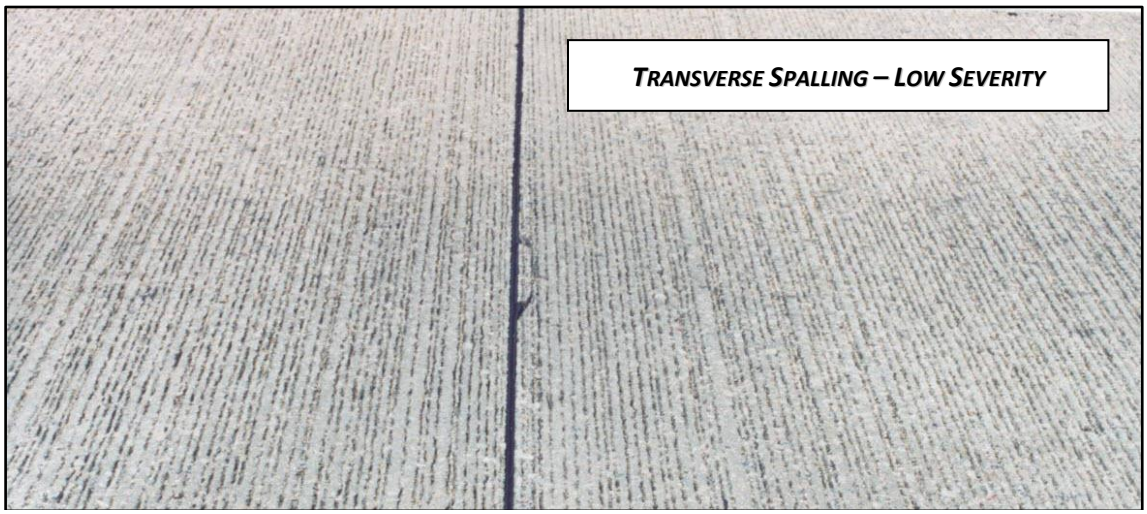
Severity Levels

Low Severity

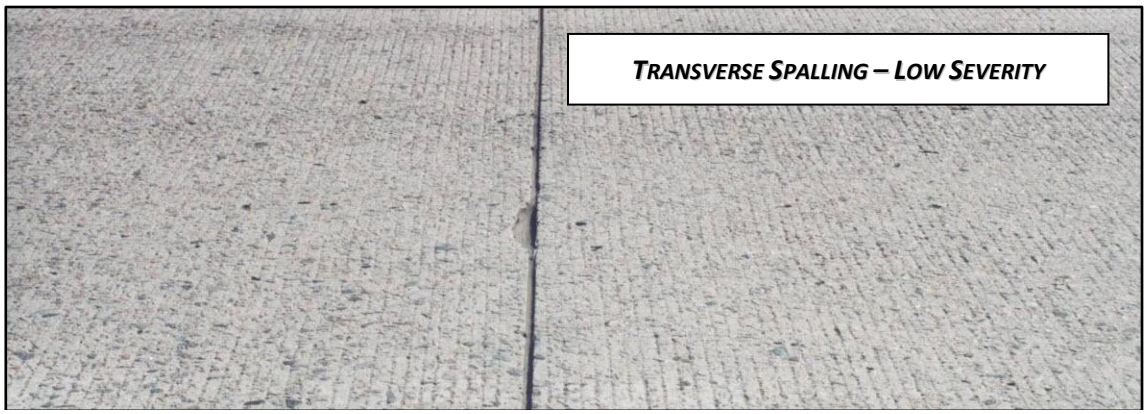
2. Spalls are less than 3 inches wide

or

3. Larger spalls with no loss of material or patching



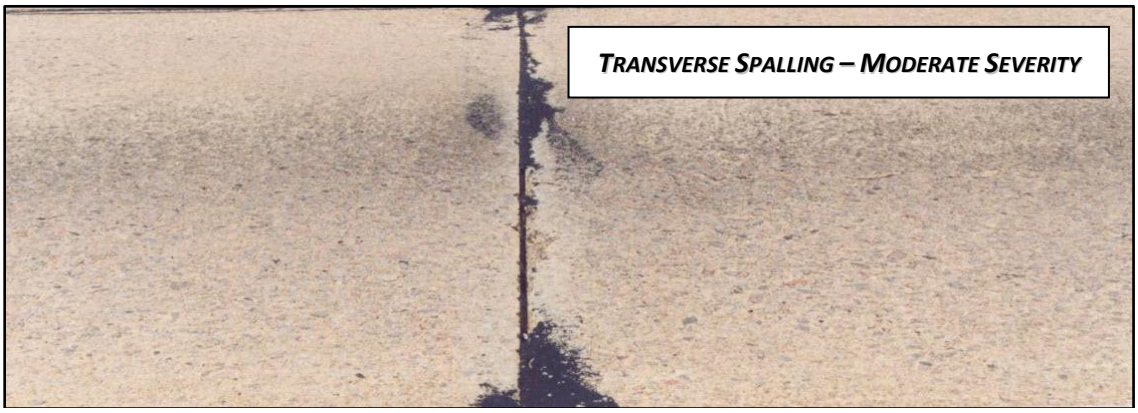
TRANSVERSE SPALLING – LOW SEVERITY



TRANSVERSE SPALLING – LOW SEVERITY

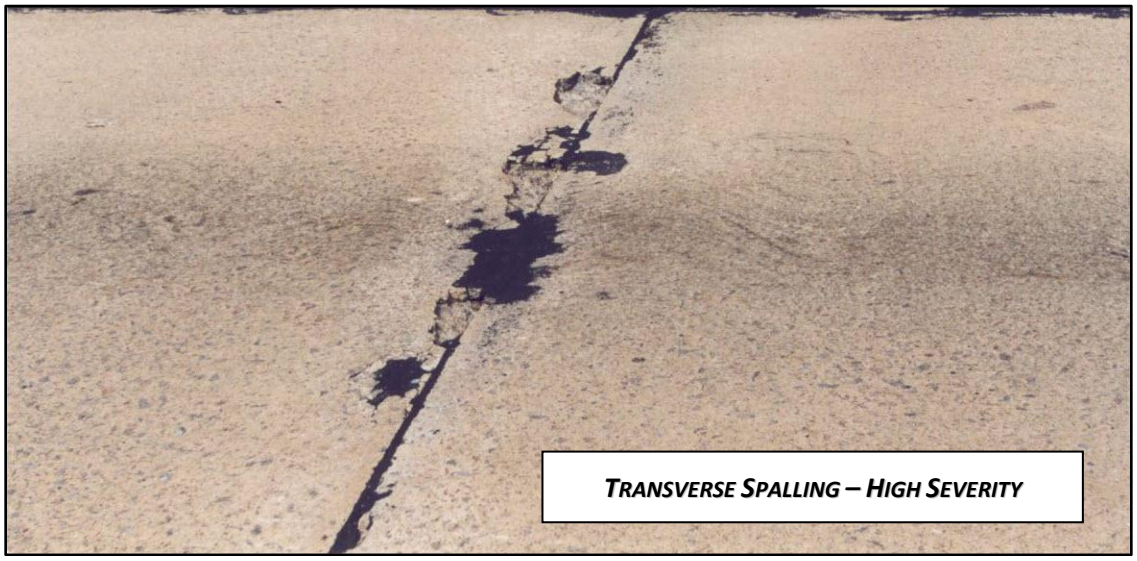
Moderate Severity

4. Spalls are from 3 to 6 inches wide with loss of material. May be patched.



High Severity

5. Spalls are greater than 6 inches wide with loss of material. May be patched.



Counting Transverse Spalling (Number of Slabs)

1. Count the number of slabs containing one or more transverse spalls.
2. For two or more spalls, the highest level of severity should be recorded.
3. A slab containing both low and moderate severity spalls would be counted as a slab containing a moderate severity spall.

The rater should note that joint seal condition, described in item 3 above, should be evaluated at the same time as joint spalling. It is described separately because of the difference in counting procedures.

Database Fields (Appendix C, Table 2)

- TRNSVRS_SPLL_LOW_NBR
- TRNSVRS_SPLL_MDRT_NBR
- TRNSVRS_SPLL_MDRT_NBR

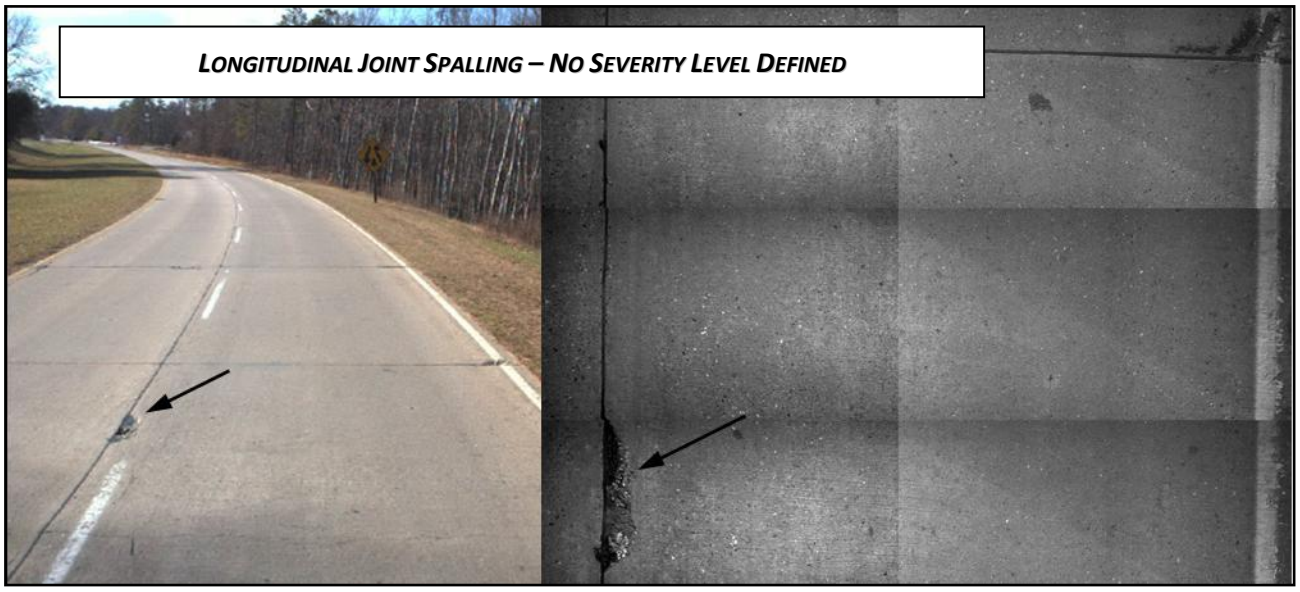
4.5 Spalling – Longitudinal Joints

Description

Breaking or chipping of slab edges along and within one foot of a longitudinal joint. Spalls may be filled with asphalt concrete.

Severity Levels

- Longitudinal spalling does not have a severity level, only an amount.



Counting Longitudinal Joint Spalling

1. Count the number of slabs with longitudinal joint spalling.
2. Spalls on slabs in the adjacent lane are not counted, but should be noted in the remarks field.

The rater should note that joint seal condition, described in item 3 above, should be evaluated at the same time as joint spalling. It is described separately because of the difference in counting procedures.

Database Fields (Appendix C, Table 2)

- LNGTDNL_JNT_SPLL_NBR

4.6 Transverse Cracking

Description

Transverse cracks are those running predominantly across the pavement (perpendicular to the pavement centerline).

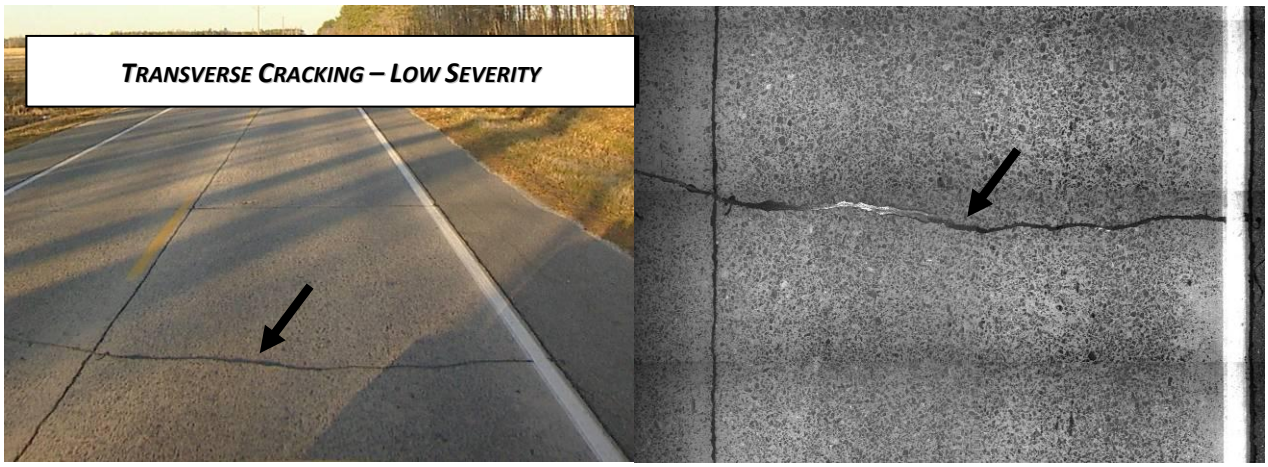
Severity Levels

Low Severity

- A crack that is well sealed so the width cannot be determined,

  or

- A closed crack that has no spalling.



High Severity

- An open crack,

  or

- Any spalled crack.

Counting Transverse Cracking (Number of slabs)

1. Count each slab containing a transverse crack more than a foot long.
2. If a slab contains two or more cracks count the highest severity level found.
3. Slabs broken into 4 or more pieces are counted as shattered slabs.

Database Fields (Appendix C, Table 2)

- TRNSVRS_CRK_LOW_NBR
- TRNSVRS_CRK_HGH_NBR

4.7 Longitudinal Cracking

Description

Cracks which are predominantly parallel to the pavement centerline.

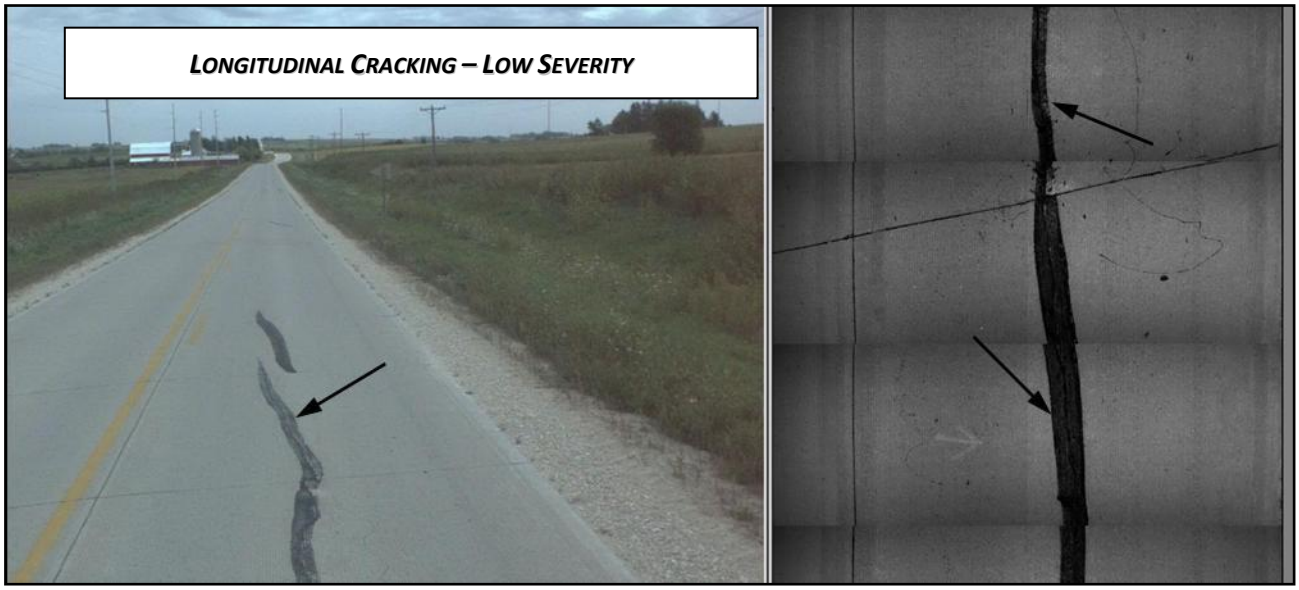
Severity Levels

Low Severity

- A crack that is well sealed so the width cannot be determined,

  or

- A closed crack that has no spalling.

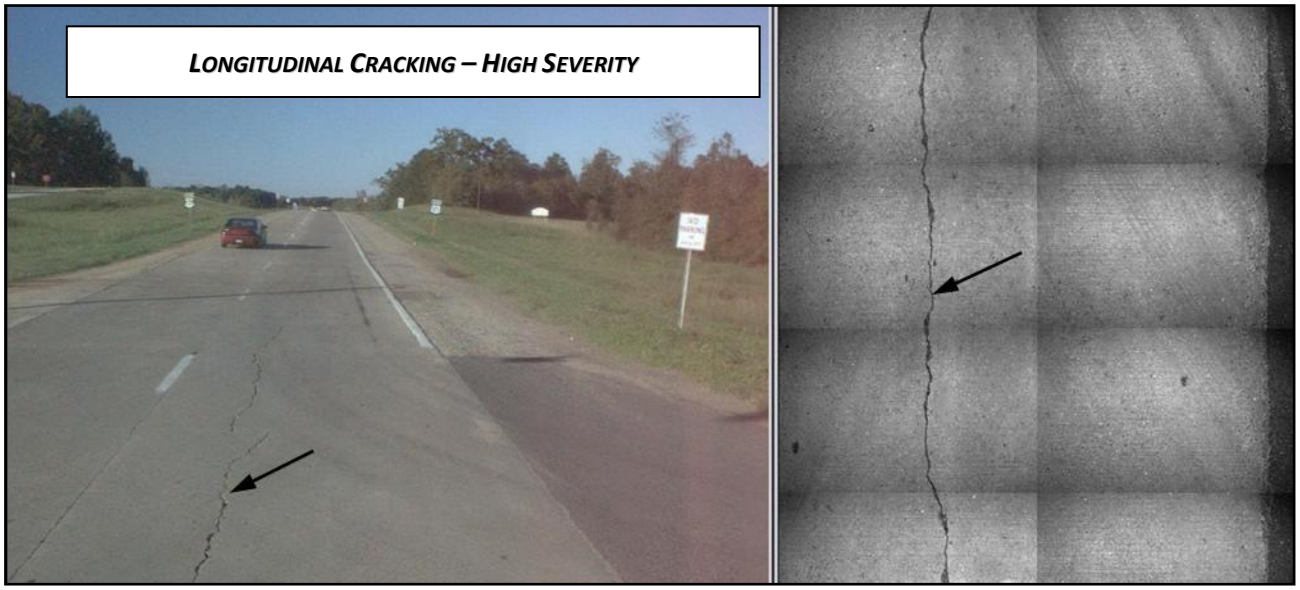


High Severity

- An open crack,

or

- Any spalled crack.



Counting Longitudinal Cracking (Number of slabs)

1. Count each slab containing a longitudinal crack more than a foot long.
2. If a slab contains two or more cracks count the highest severity level found.
3. Slabs broken into 4 or more pieces are counted as shattered slabs.

Database Fields (Appendix C, Table 2)

- LNGTDNL_CRK_LOW_NBR
- LNGTDNL_CRK_HGH_NBR

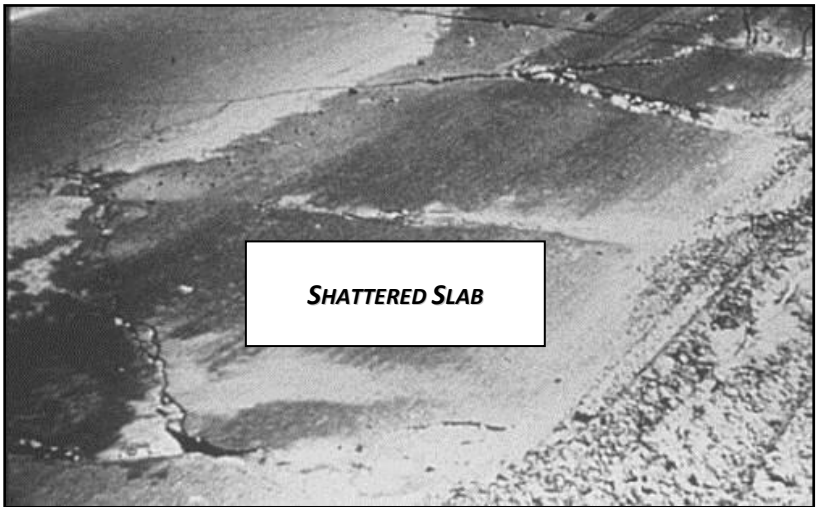
4.8 Shattered Slabs

Description

A shattered slab is one broken into four or more pieces by transverse cracks, longitudinal cracks, or a combination of the two.

Severity Levels

- The shattered slab count does not have a severity level, only an amount.



Counting Shattered Slabs (Number of slabs)

1. Count the number of shattered slabs in the section.

Database Fields (Appendix C, Table 2)

- SHTRD_SLAB_NBR

4.9 Concrete Patching and Patch Deterioration

Description

A concrete patch consists of a portion of the slab greater than 1 square foot, up to the full original slab, that has been removed and replaced. Full width patches greater than 6 feet in length are considered to be separate slabs and should be rated accordingly. Patches with a longest dimension equal to or less than 6 inches are not counted.

Care should be taken to distinguish between patching and spot grinding. Spot grinding can look substantially different from the existing concrete and lead to false ratings.

Severity Levels

Low Severity

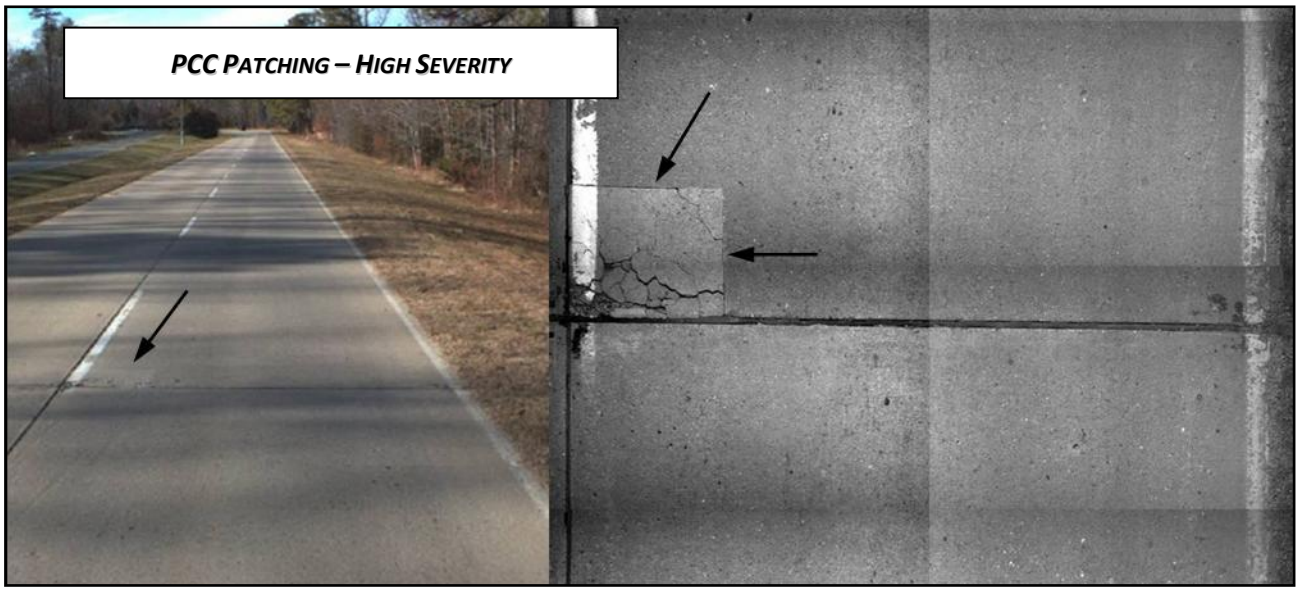
- The patch has no distress either in the patch or around its perimeter.

Moderate Severity

- The patch has low severity longitudinal cracking, transverse cracking (or any other low severity distress) either in the patch or around its perimeter.

High Severity

- The patch has spalling, moderate severity longitudinal cracking or transverse cracking (or any other moderate or high severity distress) in the patch or around its perimeter.



Counting Patching (Number of Slabs)

1. Utilize the highest severity level found on each slab.
2. Record the number of slabs in the section at each severity level.

Database Fields (Appendix C, Table 2)

- CONC_PTCH_LOW_NBR
- CONC_PTCH_MDRT_NBR
- CONC_PTCH_HGH_NBR

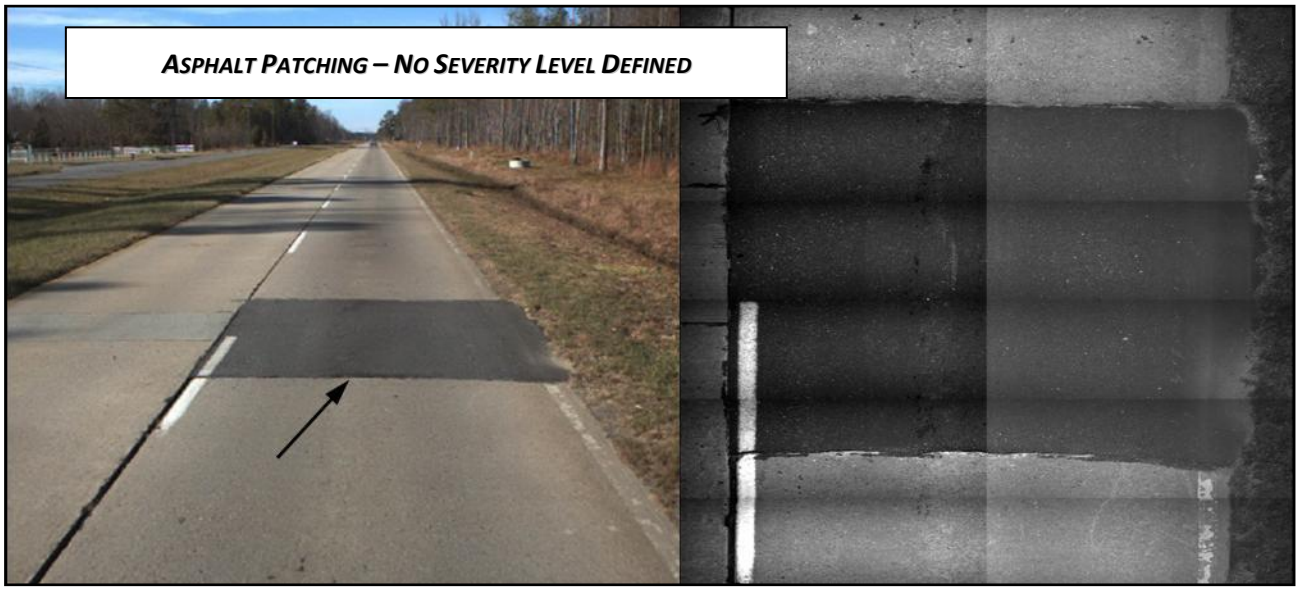
4.10 Asphalt Patching

Description

An asphalt (hot mix) patch of a PCC pavement is a temporary repair of a severely distressed area. Patches with a longest dimension of 6 inches or less are not counted.

Severity Level

- The asphalt patch count does not have a severity level, only an amount.
- All asphalt patching is considered a negative on a JCP pavement.



Counting Asphalt Patching (Number of slabs)

1. Count all slabs having one or more asphalt concrete patches.

Database Fields (Appendix C, Table 2)

- ASPHLT_PTCH_NBR

4.11 Joint Faulting

Description

Faulting is the difference in elevation across the transverse joint of a jointed concrete pavement. It is an important contributor to poor ride quality and pavement noise when present. Faulting is captured by sensors.

Severity Level

No Faulting

- Joint is faulted < 0.125 inches

Low Severity

- Joint is faulted more than 0.125 but less than 0.25 inches

Moderate Severity

- Joint is faulted between 0.25 and 0.5 inches

High Severity

- Jointed is faulted greater than 0.5 inches

Counting Faulting (Number of Joints)

1. Record the number of joints exhibiting each degree of faulting.
2. Record the average faulting calculated for the entire section.

Database Fields (Appendix C, Table 2)

- FAULT_NONE_NBR
- FAULT_LOW_NBR
- FAULT_MDRT_NBR
- FAULT_HGH_NBR
- FAULT_AVG

4.12 Fatigued Slabs

The fatigued slab count is needed for HPMS reporting purposes. A fatigued slab is defined as a slab with either transverse or longitudinal cracking, a shattered slab, or any combination thereof. Even if a slab contains more than one distress that contributes to a fatigue slab definition, the slab is counted as one slab. Corner breaks do not contribute toward the definition of a fatigue slab, although fatigue slabs might have corner breaks.

4.13 Summary of Jointed Concrete Distress Rating

A summary of the jointed PCC pavement distress rating procedures is given in *Appendix A, Table 3*.

5.0 Rating Continuously Reinforced Concrete Pavement

5.1 General CRC Rating Guidelines

1. CRC is a special class of PCC pavement designed with heavy longitudinal reinforcing steel intended to hold shrinkage cracks tightly closed. Therefore, there are few constructed transverse joints except at structures or where paving stopped for the day, etc.

2. Transverse cracks in continuously reinforced pavements are cracks that are predominantly perpendicular to the pavement centerline. *These cracks are expected in a properly functioning CRCP and technically are considered as distresses only if spalling becomes apparent or the average crack spacing is very low.*

3. Crack spacing on a CRCP can be an indicator of how well the pavement performs in the future. For that reason, as a part of CRCP evaluation NCDOT requires average transverse crack spacing to be reported.

4. On some pavements, especially in moderately distressed conditions, it may be necessary to review portions of the pavement several times as it may be impossible to capture all features in one pass.

5. On jointed concrete pavements, distresses are considered on a slab-by-slab basis. For CRC pavements, *distresses are summarized for the entire section*.

6. In some cases the instructions refer to "open" or closed" cracks. A crack width of ¼ inch determines this status. Cracks judged to be equal to or less than ¼ inch wide are considered "closed" and those greater than ¼ inch wide are considered "open".

5.2 Transverse Cracking

Description

While transverse cracks are a design feature of CRCP pavements, those with spalling can be forerunners of serious pavement performance problems. Therefore, both average transverse crack spacing and an evaluation of spalled transverse cracks are required to properly characterize pavement condition.

Unspalled “Y” cracks are to be counted as transverse cracks while spalled "Y" cracks are handled separately below.

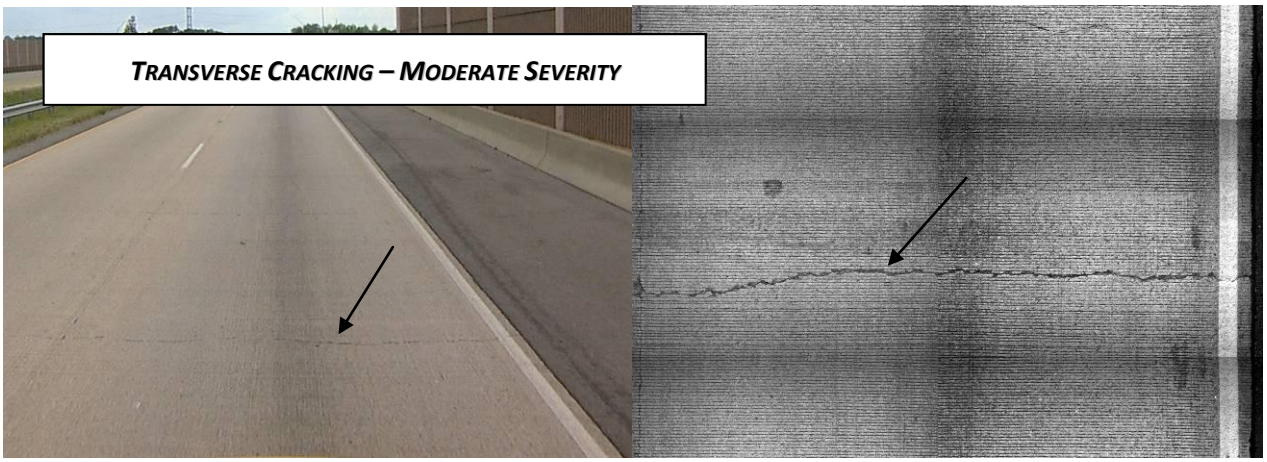
Severity Levels

Low Severity

- A closed transverse crack with no spalling.

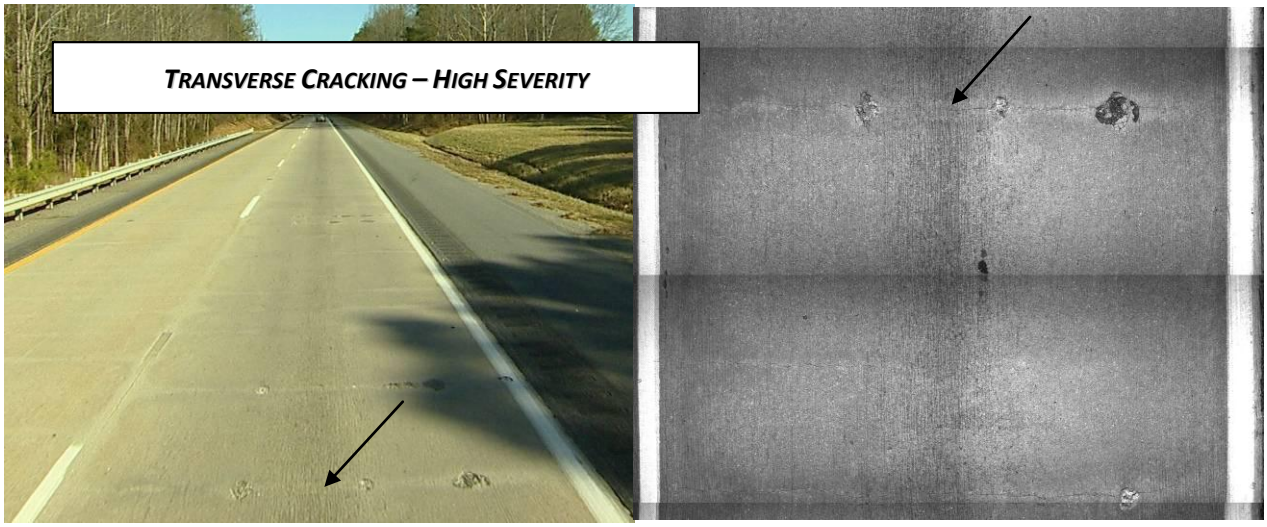
Moderate Severity

- An open (>1/4”) transverse crack with no spalling.



High Severity

- Any transverse crack with spalling.



Counting Transverse Cracking (linear feet)

1. The pavement rater should evaluate each crack by severity level as it is traversed. Rate each crack at the highest severity level present on a significant portion of the crack.
2. The rater reports the number of cracks by severity level for the actual length.
3. NOTE: Cracks counted as a part of "Clustered Cracking" below are NOT counted as separate transverse cracks.
4. Transverse cracks less than half a lane width are not counted; only those that are more than half a lane width are counted.
5. Unspalled "Y" cracks with the divided portion of "Y" more than half a lane width are counted as two transverse cracks, if less than half a lane width it is counted as a single transverse crack.
6. A report of average transverse crack spacing to the nearest tenth of a foot (0.1) is required. The software should calculate this average by dividing the total number of cracks into the section length.

Database Fields (Appendix C, Table 3)

- TRNSVR_CRK_LOW_LF
- TRNSVR_CRK_HGH_LF
- TRNSVR_CRK_MDRT_LF
- TRNSVR_CRK_NBR
- TRNSVR_CRK_AVG_SPC

5.3 Clustered Cracking

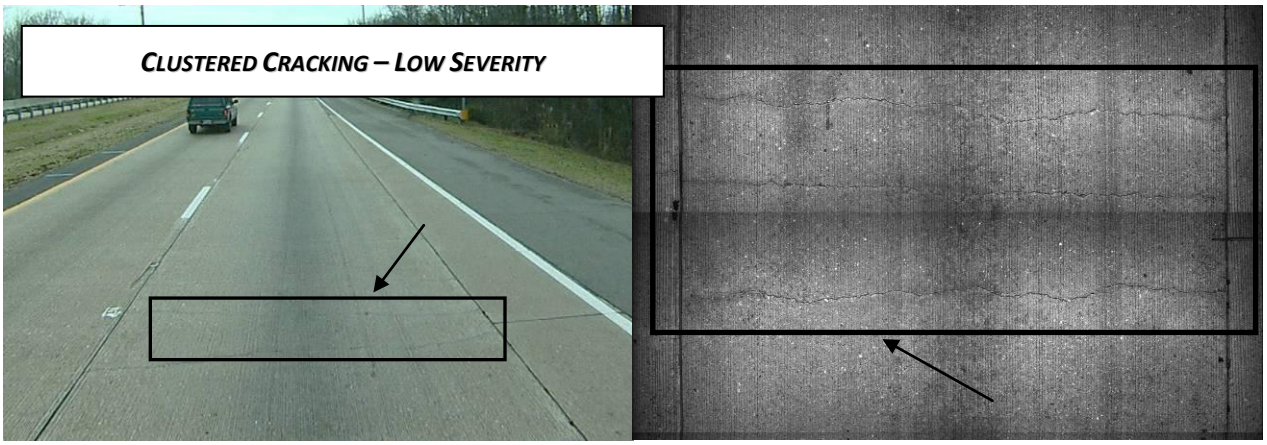
Description

Clustered Cracking in CRCP pavements is defined as a group of three or more transverse cracks having an average spacing of 2 feet or less. If the spacing between two consecutive transverse cracks is more than 3 feet, the cluster cracking ends. At the next crack, the next cluster cracking begins or a separate transverse cracking is recorded.

Severity Levels

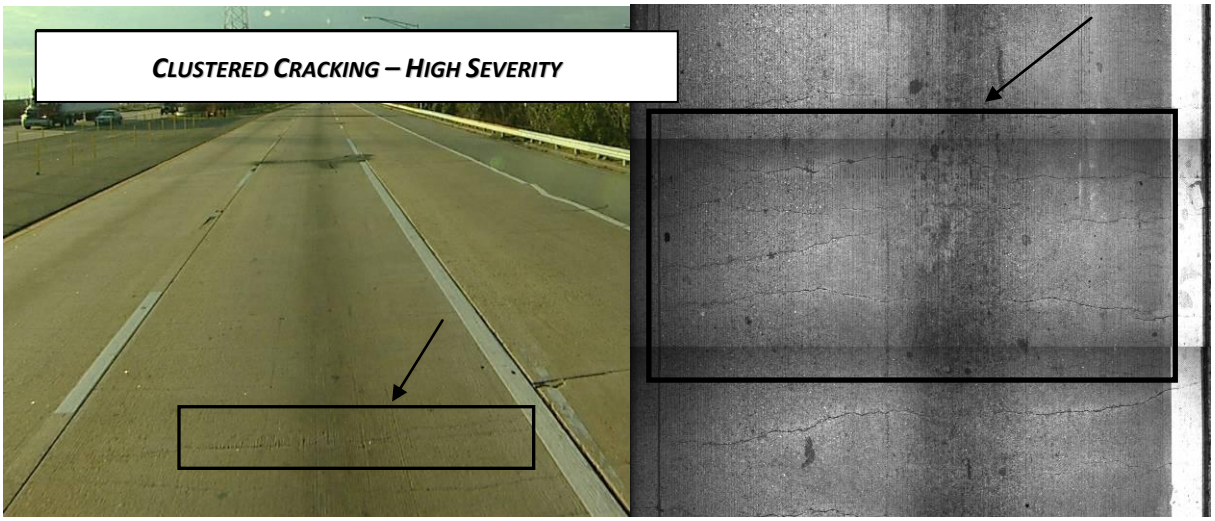
Low Severity

- Clusters of three or more transverse cracks having an average spacing greater than 1 foot and less than or equal to 2 feet.



High Severity

- Clustered cracks with an average spacing of less than or equal to 1 foot.



Counting Clustered Cracking (Number of occurrences and Square feet)

1. Count and record each cracking cluster by severity level for the section.
2. In addition, the area of clustered cracking in square feet by severity level shall be reported for the section.

Database Fields (Appendix C, Table 3)

- CLSTR_LOW_NBR
- CLSTR_HGH_NBR
- CLSTR_LOW_SF
- CLSTR_HGH_SF

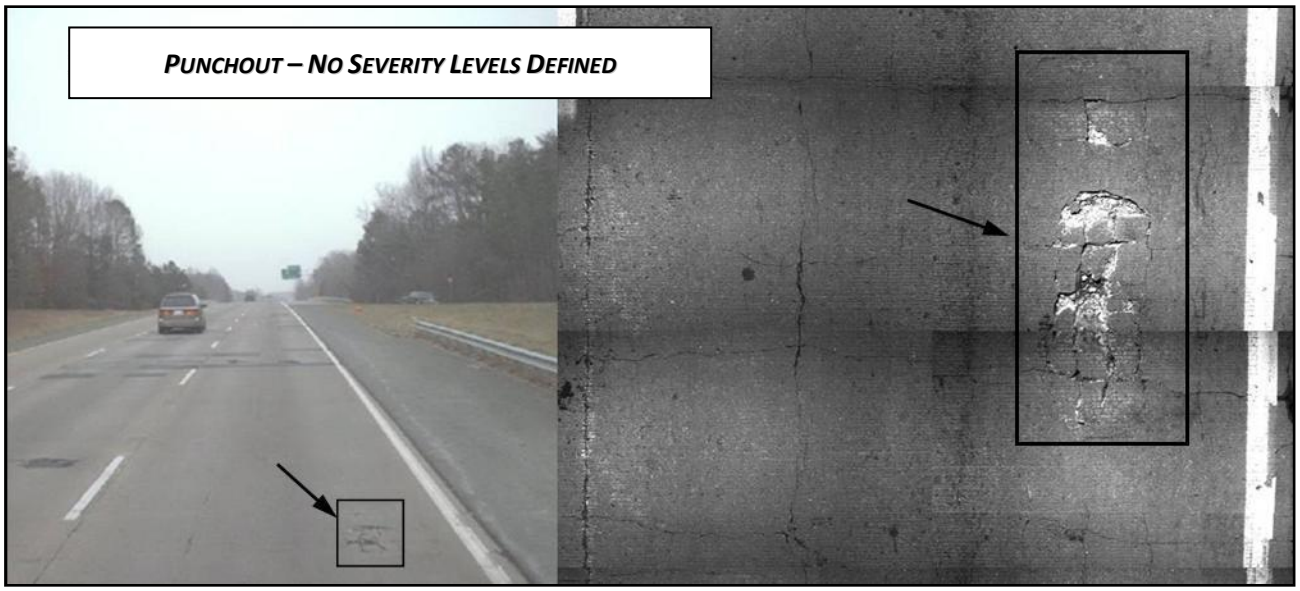
5.4 Punchouts and Spalled "Y" Cracks

Description

A punchout is a localized section of the slab broken into two or more pieces. Often punchouts are shaped by two closely spaced (usually less than 2 feet) transverse cracks, a short longitudinal crack, and the edge of the pavement or a longitudinal joint. "Y" cracks with spalling are considered as incipient punchouts. A "Y" crack is created when one transverse crack begins within another transverse crack and radiates to the edge of pavement forming a Y.

Severity Levels

- Individual distress levels are not recorded.
- All punchouts and "Y" cracks with spalling are not assigned to a severity level since once a punchout occurs, it progresses rapidly to the worst severity and has to be patched.



Counting Punchouts (Number of occurrences and square feet)

1. Count and record each punchout and spalled "Y" crack.
2. Record the total punchout / spalled "Y" crack size in square feet for the section.

Database Fields (Appendix C, Table 3)

- PNCH_NBR
- PNCH_SF

5.5 PCC Patch / Patch Deterioration

Description

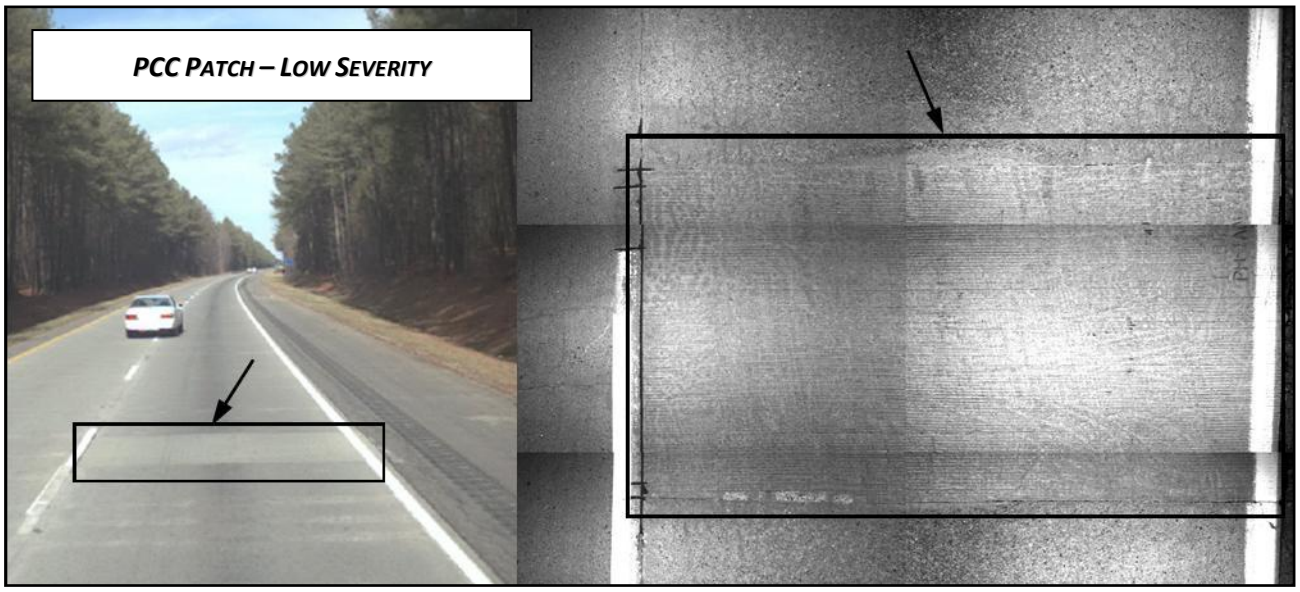
A portion greater than 1 square foot, up to the full original lane width, that has been removed and replaced; in some cases additional material that has been added to the surface since original construction. Patches with a longest dimension of less than 6 inches are not counted.

Care should be taken to distinguish between patching and spot grinding. Spot grinding can look substantially different from the existing concrete and lead to false ratings.

Severity Levels

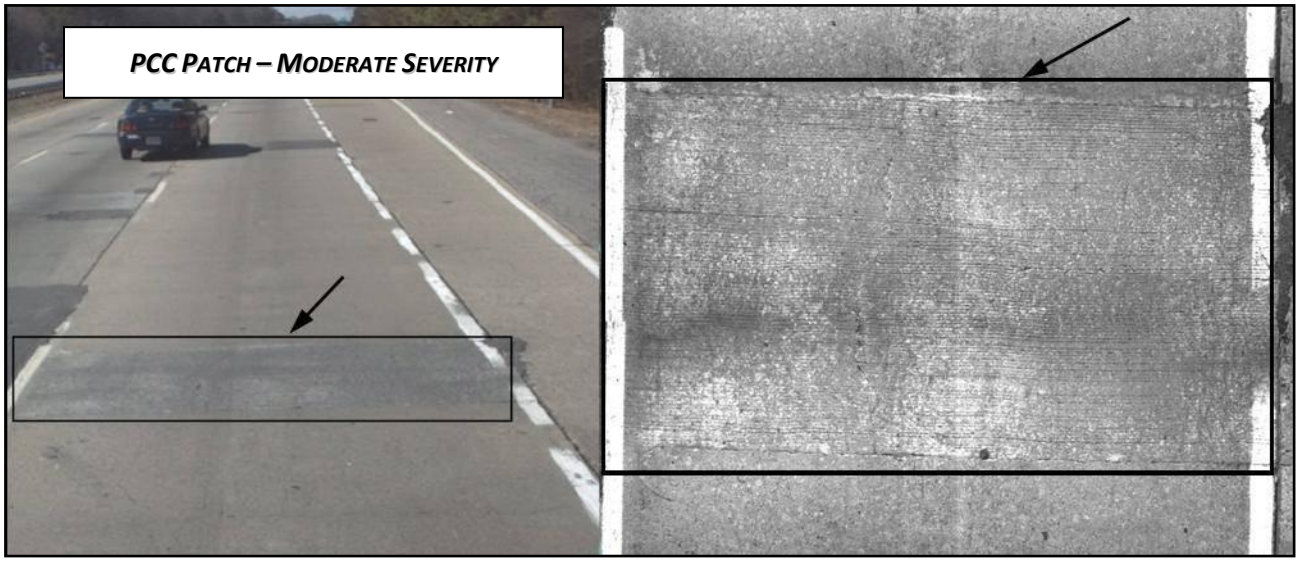
Low Severity

- The patch has no distress either in the patch or around its perimeter.



Moderate Severity

- The patch has any type of low severity CRCP distress either in the patch or around its perimeter.



High Severity

- The patch has any type of moderate or high severity severity CRCP distress either in the patch or around its perimeter.

Counting PCC Patching (Number and area)

1. Count the number of PCC patches by severity level found in the pavement section
2. Count the area of PCC patching in square feet by severity level found in the pavement section.

Database Fields (Appendix C, Table 3)

- CON_PTCH_LOW_NBR
- CON_PTCH_MDRT_NBR
- CON_PTCH_HGH_NBR

- CON_PTCH_LOW_SF
- CON_PTCH_MDRT_SF
- CON_PTCH_HGH_SF

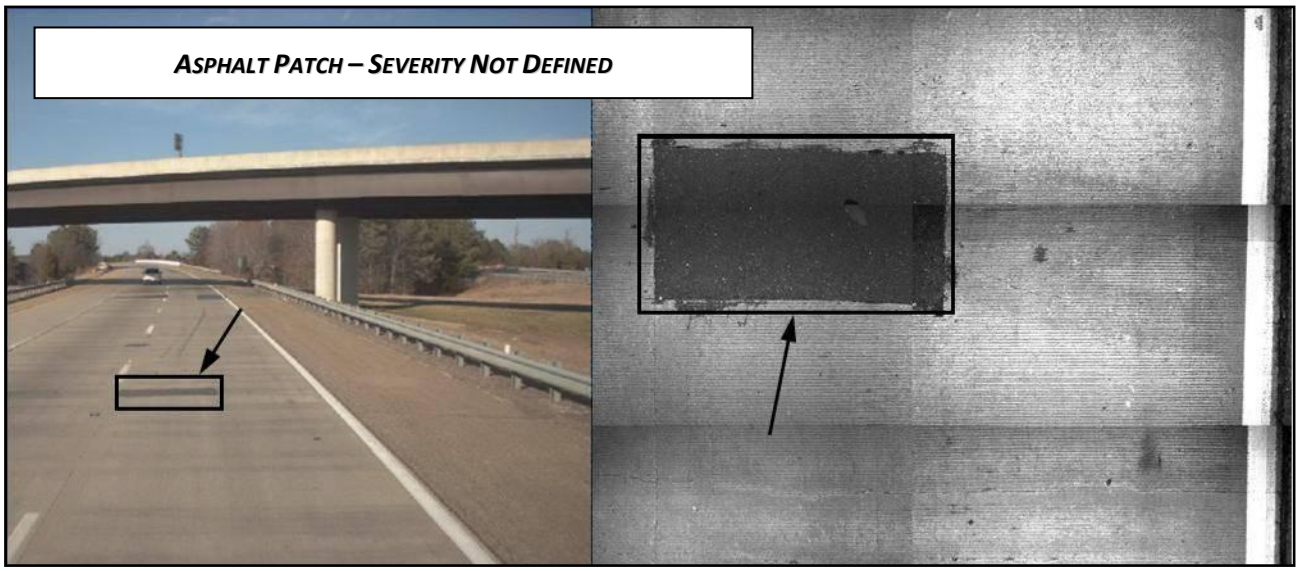
5.6 Asphalt Patches

Description

An asphalt (hot mix) patch of a PCC pavement is a temporary repair of a severely distressed area. Only patches with a longest dimension of greater than 6 inches are counted.

Severity Level

- No severity level is recorded.
- ALL asphalt patches on a concrete pavement are a negative and should only be considered temporary repairs.



Counting Asphalt Patches (Number and Area)

1. Count the number of distinct asphalt patches found in the section
2. Count the area of asphalt patching (one square foot or more) found in the section.

Database Fields (Appendix C, Table 3)

- ASPHLT_PATCH_NBR
- ASPHLT_PTCH_SF

5.7 Longitudinal Cracking

Description

Cracks predominantly parallel to the pavement centerline.

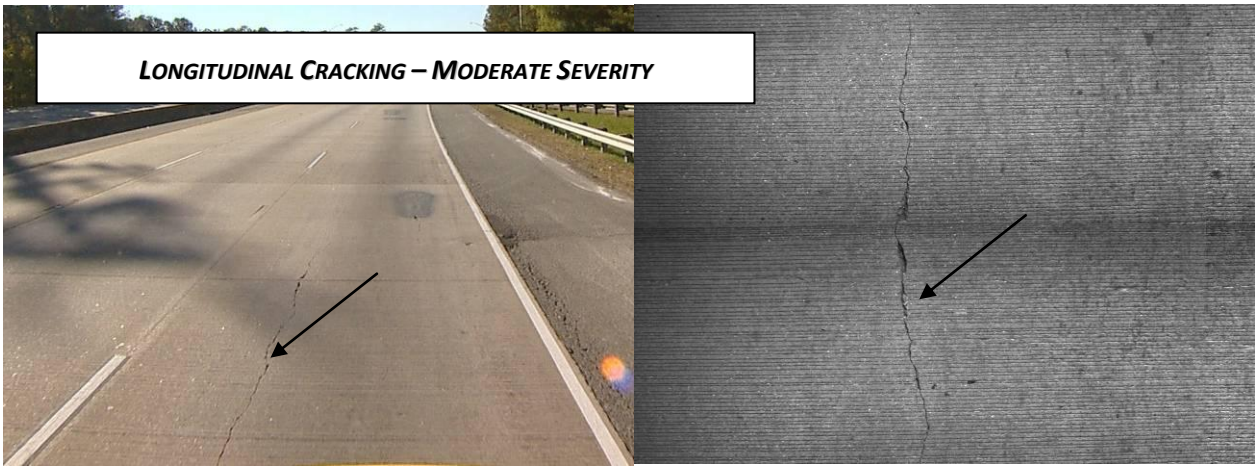
Severity Levels

Low Severity

- A longitudinal crack with no spalling.

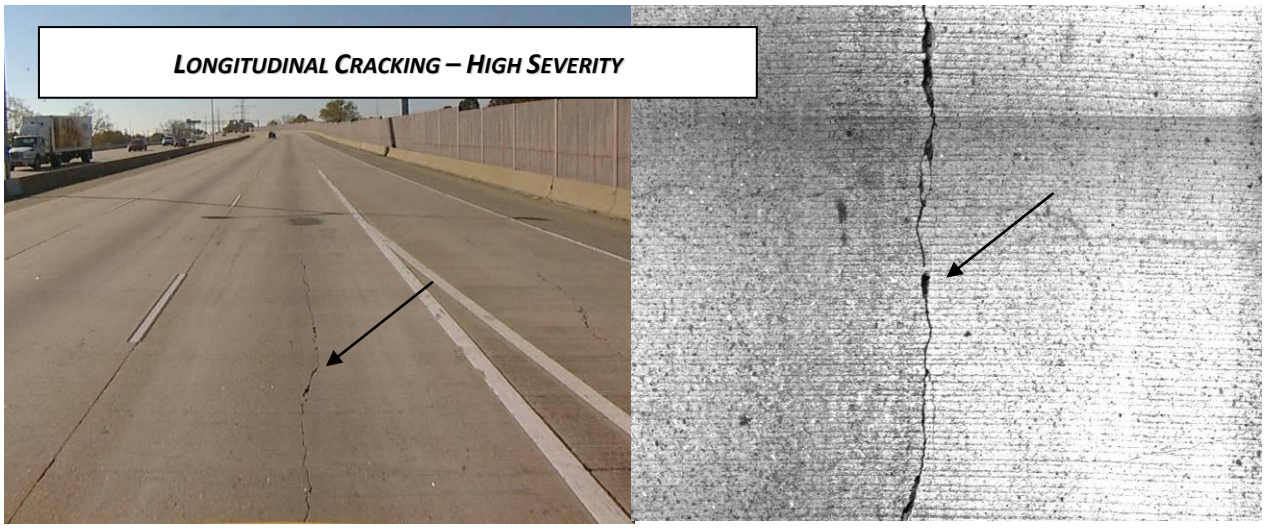
Moderate Severity

- A longitudinal crack with spalling on less than or equal to ¼ of the crack length.



High Severity

- A longitudinal crack with spalling on greater than ¼ of the crack length.



Counting Longitudinal Cracking (Number and Linear feet)

1. Count cracks greater than 1 foot in length.
2. For the pavement section, record length of longitudinal cracks at each severity level.

Database Fields (Appendix C, Table 3)

- LNGTDNL_CRK_LOW_LF
- LNGTDNL_CRK_MDRT_LF
- LNGTDNL_CRK_HGH_LF

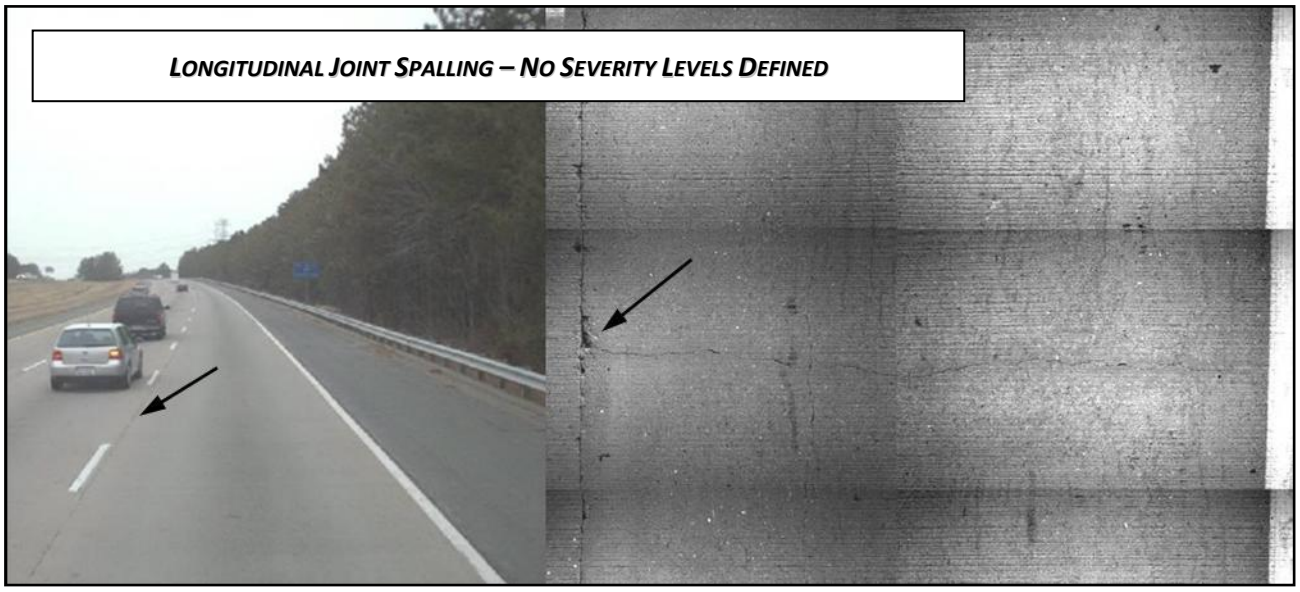
5.8 Longitudinal Joint Spalling

Description

Breaking or chipping of concrete slab edges along and within one foot of a longitudinal joint. Spalls may be filled with asphalt concrete.

Severity Levels

- No severity levels are defined.



Counting Longitudinal Joint Spalling (Linear feet)

1. Record the length of longitudinal joint spalling found in the pavement section.

Database Field (Appendix C, Table 3)

- LNGTDNL_SPLL_LF

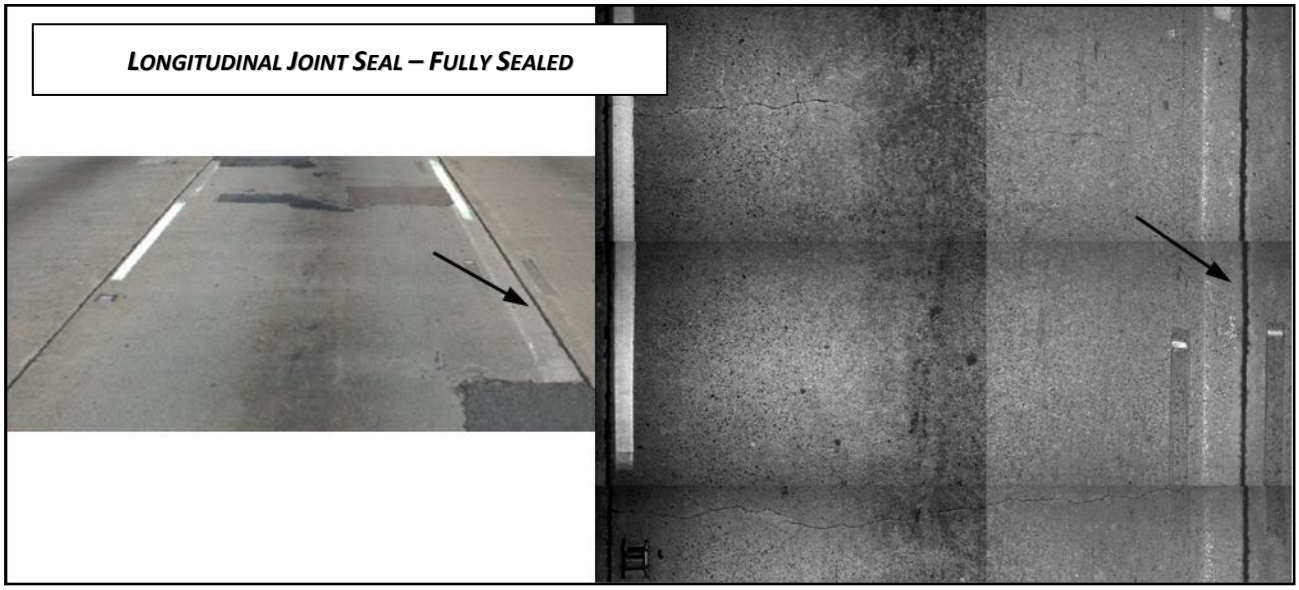
5.9 Longitudinal Pavement / Shoulder Joint Seal Condition

Description

A joint seal is considered damaged whenever the seal will permit the infiltration of water and incompressible materials from the surface. A sealed joint is defined as one that appears from the image to be capable of resisting the infiltration of surface water. For the purposes of rating pavement/shoulder joint seal condition from images, they are considered to be either fully sealed or unsealed. If greater than 90% of the pavement/shoulder joint appears to be sealed the entire joint is considered to be sealed, otherwise the entire joint is considered to be unsealed.

Severity Levels

- No severity levels are defined.
- A longitudinal is either sealed or not sealed.



Counting Longitudinal Pavement/Shoulder Joint Seals

1. Estimate percent of fully sealed longitudinal pavement/shoulder joint in the section.
2. If ninety (90) percent or more appears to be sealed, the entire joint is considered sealed and "Y" should be recorded.

Database Field (Appendix C, Table 3)

- LNGTDNL_SEAL

5.10 Summary of Continuously Reinforced Concrete Distress Rating

A summary of continuously reinforced pavement (CRCP) distress rating procedures is given in Appendix A, Table 4.

6.0 Rating Shoulders

6.1 General Guidelines for Rating Shoulders

1. The shoulder is the pavement surface outside the marked lane boundary. Condition assessment of the paved shoulder will be subjective and simple for safety, convenience and efficiency.

2. Both the Right and Left shoulders will be evaluated individually.

3. Evaluations include the type of surface(s), condition(s), and width(s).

4. A maximum of two different shoulder types are allowed for any given shoulder.

5. No shoulder ratings are required when no pavement striping occurs on the right or left edge.

6.2 Shoulder Types

Description

Shoulder type is to be defined based on seven different categories of shoulder type:

- Curb and gutter
- Gravel
- Asphalt
- Concrete
- Paved combination (asphalt + concrete)
- Unpaved combination (gravel + turf)
- No shoulder

6.3 Shoulder Width

Description

The rater is to estimate the width of the different shoulder surfaces and record for each surface type. Widths should be reported based upon the following, if no shoulder is present report 0:

Average paved width:

- 0 feet to 1 foot, report 0 foot
- 1 to 3 feet, report 2 feet
- 3 to 6 feet, report 4 feet
- 6 to 9 feet, report 8 feet
- Greater than 9 feet, report 12 feet.

6.4 Shoulder Condition

Description

There are three severity levels for the condition of the paved material. Provide a condition rating for each material type.

Severity Levels

Low Severity

- The shoulder is in relatively good condition.
- The existing cracks (all types) and break-up, if any, are very minor.
- There are no distortions (like rutting, pushing or shoving) in the shoulder.

Moderate Severity

- The shoulder is in fair condition.
- The existing cracks (all types) and break-up could affect some of the shoulder area but do not affect more than 50% of the shoulder area.
- There could be some distortions (like rutting, pushing or shoving).

High Severity

- The shoulder is in poor condition.
- The existing cracks (all types) and break-up are significant and affect more than 50% of the shoulder area.
- The distortions (like rutting, pushing or shoving) in the shoulder, if any, affect a significant portion of the shoulder area and could create a safety hazard if left untreated.

Counting Shoulder Condition (linear feet)

The entire section length is recorded for the predominant condition. Generally speaking, this means that 528 feet will be entered in one condition column (with shorter or longer sections having correspondingly different lengths).

6.5 Deficient Slope

Description

If the slope of the shoulder is such that water does not drain away from the roadway, it is said to have deficient slope.

Severity Levels

- There are no severity levels for deficient slope.

Counting Deficient Slope (linear feet)

1. The rater records the length of the shoulder with a deficient slope in the section.

6.6 Shoulder Build-up

Description

Shoulder build-up is defined as vegetation growth or debris build-up that adversely affects the drainage.

Severity Levels

- No severity levels are defined for build-up.

Counting Shoulder Build-up (linear feet)

1. The rater records the length of built-up shoulder in the section.

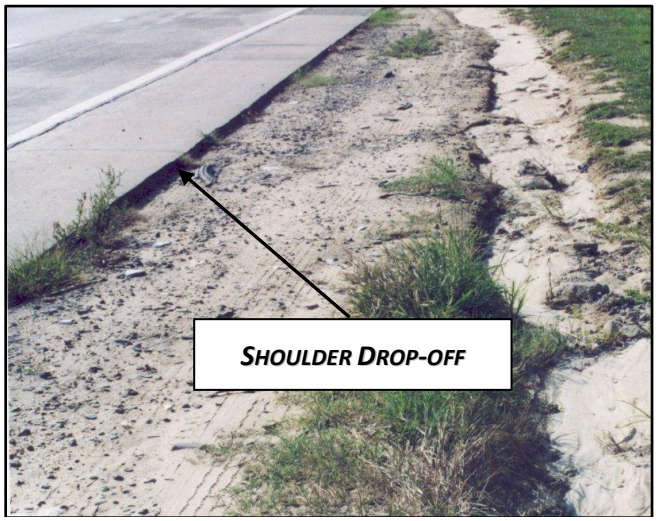
6.7 Shoulder Drop-off

Description

Shoulder drop-off is the difference in elevation between the traveled surface or paved shoulder and the earth or gravel shoulder. Typically occurs when the outside shoulder settles as a result of pavement layer material differences. Record the length of shoulder experiencing a drop-off equal to or greater than 2 inches.

Severity Levels

- No severity levels are defined for drop-off



Counting Shoulder Drop-off (linear feet)

1. Might be limited by visual measurement.
2. Record the length of shoulder experiencing a drop-off of greater than 2”

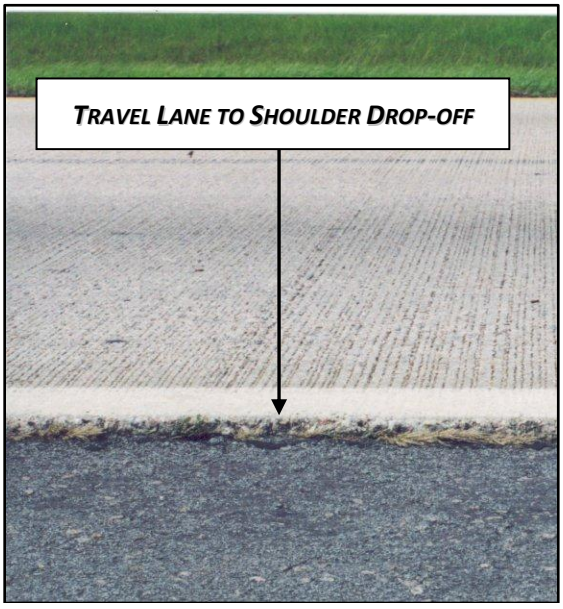
6.8 Travel Lane to Shoulder Drop-off

Description

Travel lane to shoulder drop-off is the difference in elevation between the traveled surface and the paved shoulder. Shoulder settlement or material differences often play a role in the development of elevation differences. The length of pavement with a drop-off greater than 0.5 inches should be recorded.

Severity Levels

- No severity levels are defined for lane to shoulder drop-off



Counting Lane to Shoulder Drop-off (linear feet)

1. Might be limited by visual measurement.
2. Record the length of shoulder experiencing a drop-off of greater than 0.5”
3. If possible, sensor-based means should be used to measure this value.

6.9 Summary of Shoulder Distress Rating

A summary of left and right shoulder distress rating procedures is given in *Appendix A, Table 5*.

7.0 General Data Collection and Rating Procedures

This chapter summarizes the requirements and procedures necessary to collect and process pavement distress information compatible with the NCDOT requirements. The objective of automated pavement condition data collection and analysis is to provide and update a database of pavement condition information for use in the management of NCDOT pavements.

The components of that database are the appropriate location-reference landmarks, the various pavement surface distresses, and the elements of longitudinal and transverse pavement profiles as set forth below. The vendor shall have the demonstrated capability of efficiently collecting pavement condition data through laser and digital camera equipped automated collection equipment and of automatically (or a combination of manual and automatic) reducing images and quantifying visual pavement distresses from the digital images captured.

7.1 Data Collection Requirements

7.1.1 Linear References

The Asset Management System uses route and mile-point for identifying pavement locations. The mile-points are county-relative locations with a zero at the county line or at a route's begin milepost. The route milepost resets at each county line. See Appendix D for more details on the NCDOT route numbering and mile posting system used in the Pavement Management System. The county relative mile-point system will be used as the linear referencing system for data collected by the vendor.

- All pavement condition data shall be summarized in one-tenth (0.100) mile sections starting at the mile-point 0.000 beginning at county boundaries or route begin points. Mile points typically increase from south to north and west to east depending on the assigned direction of the route.

- The final arbiter for mile post direction should be the shape file and/or NCDOT Geometrics Report.

- Where data are to be collected in only one direction, the data collection vehicle shall travel in the direction of increasing mileposts.

    - The PMS_DRCTN_CD shall be populated with the letter I (eye) to indicate an increasing milepost direction of travel.

- Where it is necessary to run against mileposts due to traffic circumstances or when running the opposing direction on a 3+ lane undivided route, data is to be reported as if run with the mileposts. Therefore, the "to" milepost will always exceed the "from" milepost.

    - The PMS_DRCTN_CD column shall be populated with the letter "D" to indicate data was collected in a direction opposite increasing mileposts.

- The tenth mile sections will be broken at overlaps of higher priority routes, and the next county boundary. For instance, when I-85 merges with I-40, data will be carried on I-40.

- At each break of this type, the last section length will be less than one-tenth mile, that length dependent on the distance from the last even one-tenth mile section to the break point.

- When the end of the break is reached, regardless of the jurisdictional relative mile-point, a new pavement sectioning of one-tenth mile increments shall begin.

- When two or more routes run concurrently on the same location, mileposts are assigned to the higher classed route.

- If routes of the same class run concurrently mileposts are assigned to the lower route number.

7.1.2: Sensor Data Requirements

Pavement condition data collected by sensors (IRI, Rutting, and Faulting Data) are that the equipment shall conform to the latest version of ASTM Designation E1656/E1656M, "Standard Guide for Classification of Automated Pavement Condition Survey Equipment". All inertial profilers shall be a Class 1 Inertial Profiler per ASTM E950.

- When multiple data collection vehicles are used, it shall be demonstrated that all vehicles are calibrated to produce between vehicle measurement differences (IRI, rutting data) of 5% or less.

- The Contractor shall collect and capture Downward Perspective Images of the pavement surface to produce a full 14-foot width view of the pavement surface for a visual pavement distress condition evaluation. These images shall be collected from downward pointing camera(s), which are orthogonal to the pavement surface. The Contractor must demonstrate that the resultant video image has a resolution to identify cracking of 1/8th inch width when traveling at survey speeds.

- The Downward Perspective Image shall be collected with a uniform and consistent form of illumination applied to the pavement surface. The illumination shall be regulated to provide sufficient contrast and crack-shadows for the clear discernment of cracking and patching. Images bearing ambient and/or vehicle shadows that obscure pavement features will not be accepted.

- The Contractor shall collect and capture a Forward Perspective Image of the roadway surface, from a camera pointed ahead of the vehicle and mounted either to the vehicle roof or just inside the windshield.

- The Forward Perspective Image shall resemble a windshield view of the roadway such that the pavement surface and condition in the travel lane ahead of the survey vehicle shall be captured.

- The forward perspective image shall have a resolution to identify ¼-inch wide cracks on the pavement immediately ahead of the survey vehicle when traveling at highway speeds.

- The downward and forward cameras shall be synchronized such that both simultaneously image the same roadway location.

7.2 Data Processing Requirements

The contractor will evaluate pavement surface distresses on 100% of the pavement sections (continuous) utilizing the downward and forward perspective images.

7.2.1 Location of Distress

The classification of several distresses depends upon the location within the roadway of that distress, that is, whether the distress falls within the wheel path or outside of the wheel path. For this reason, NCDOT has identified the road-zones as illustrated in Chapter 2. Each wheel path should always be 3.5 feet wide. The minimum edge width should be 6 inches but it can be larger. The maximum lane center width is 3.5 feet. For roads with narrower lanes the lane center is the variable and should be adjusted depending on the width of the lane. When the lane exceeds 11.5 feet, the edge widths will be greater than 6 inches.

The pavement to be included in the ratings is the area between the pavement stripes. Any cracking or other distresses that fall in or beyond the pavement striping is not reported. Paving joints are only considered a distress when they are cracked or open. If a paving joint is visible, but it is not opened up, then no distress is reported.

If automated pavement distress identification is utilized, the vendor must provide for a semi-automated visual review of all pavement sections prior to submitting results. This review will not only check the reasonableness of the automated ratings, but will specifically identify the presence of crack or joint sealant, patching, bleeding and other distresses which may not be classified in the automated system.

7.2.2 General Guidelines for Collecting and Summarizing Data

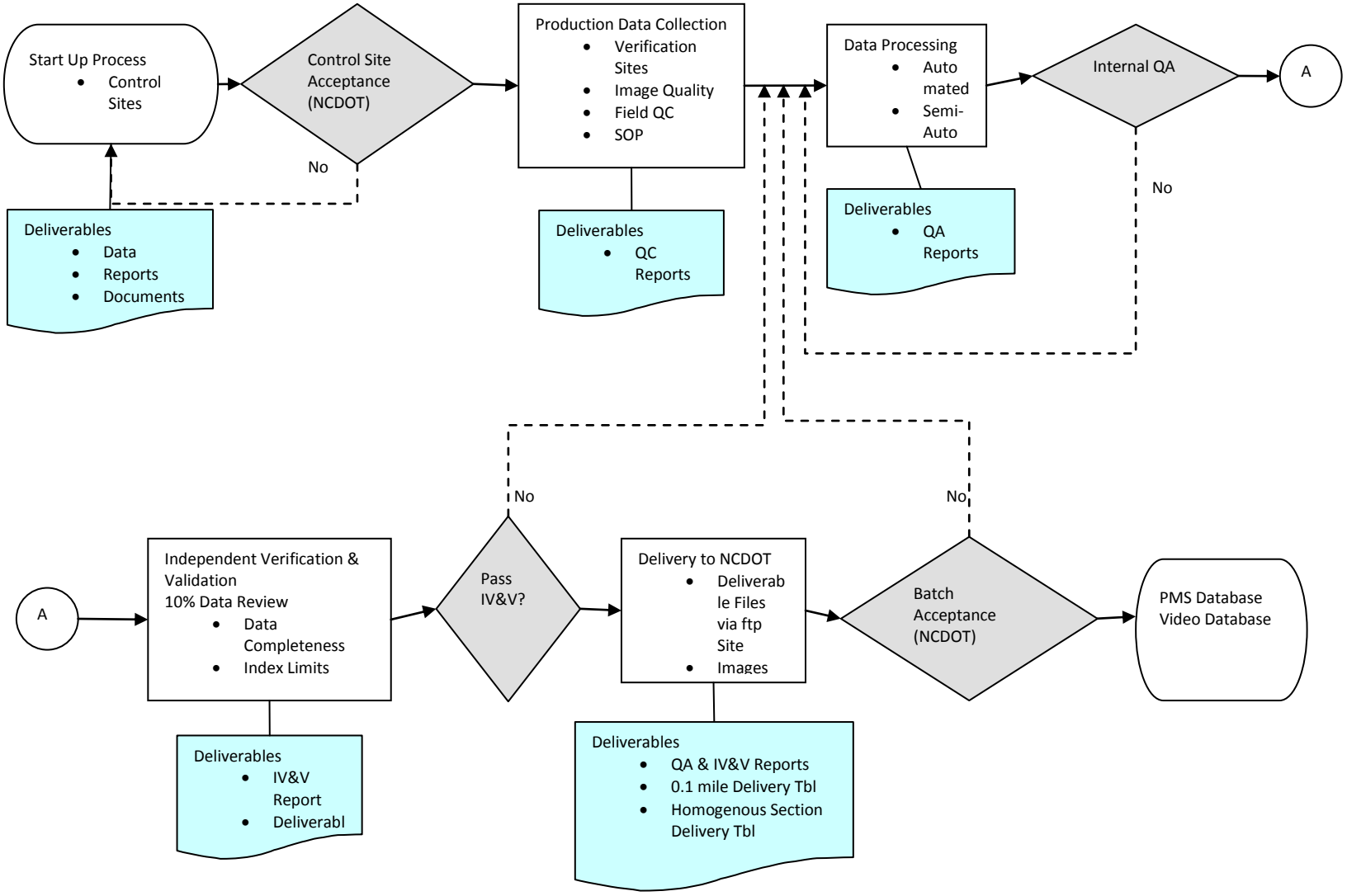
- The vendor shall use a proven, documented, and demonstrated system for the processing of collected distresses.
- The reduction of images and processing of distresses should be mostly automated and consistent, with limited manual intervention to meet the requirements herein.
- For reporting purposes, all distress and sensor collected data shall be summarized and indices calculated separately for each tenth of a mile of roadway and also for every homogenous section as provided by NCDOT.
- These results will be summarized in data tables constructed per Appendix C.
- For the 0.1 mile sections, the distresses will be summarized and the indices calculated for every tenth of a mile.
- Data will be summarized for each homogeneous section (typically from 0.1 miles to 2.0 miles in length).

- For homogeneous sections, if data was collected in both increasing and decreasing directions, the data will be merged and data from both sides of the road used to calculate distress and index information. This will typically occur on routes that are 3 lanes or more with a center turn lane.

7.3 Quality Control and Acceptance

The contractor shall develop and implement a distress data assessment quality control plan that shall be approved by the NCDOT Project Manager before distress data assessment commences. As a minimum, the quality control plan shall provide for internal random assessment of the Contractor's work and shall be an integral part of the overall quality control plan for the project. A sample quality monitoring flow diagram follows.

NCDOT will institute an independent validation and verification (IV&V) check that will monitor the Contractor's assessment of pavement distress data. The Contractor is required to cooperate with NCDOT and the QA/QC contractor in providing such data as required for analysis. The NCDOT plan will provide for final statistical acceptance of the Contractor's work based on a comparison of pavement condition distresses (extent and severity) and indices computed from distress data and images provided by the contractor. When 90% of the Contractor and IV&V determined indices or distresses for randomly selected sections are within 10 points (or the value determined from a D2S evaluation of contractor and NCDOT data that has been reviewed and approved by the NCDOT Project Manager) of each other, the lot shall be accepted. When the previous criterion is not met, the burden of proof shall be on the Contractor to make any required adjustments and/or reprocessing and for resubmitting the lot at no additional cost to the Department.


Start Up Process
Control Sites
Control Site Acceptance (NCDOT)
No
Deliverables
Data
Reports
Documents
Production Data Collection
Verification Sites
Image Quality
Field QC
SOP
Deliverables
QC Reports
Data Processing
Auto mated
Semi-Auto
Deliverables
QA Reports
Internal QA
A
No
No
No
A
Independent Verification & Validation
10% Data Review
Data Completeness
Index Limits
Deliverables
IV&V Report
Deliverabl
Pass IV&V?
Delivery to NCDOT
Deliverable Files via ftp Site
Images
Deliverables
QA & IV&V Reports
0.1 mile Delivery Tbl
Homogenous Section Delivery Tbl
Batch Acceptance (NCDOT)
PMS Database
Video Database

REFERENCES

1. Strategic Highway Research Program, "Distress Identification Manual for the Long-Term Pavement Performance Project", National Research Council, Washington, DC, 1993

2. ASTM Designation: E1656, "Standard Guide for Classification of Automated Pavement Condition Survey Equipment", ASTM, 1994.

3. ASTM Designation: E867, "Standard Terminology Relating to Traveled Surface Characteristics", ASTM, 1994.

4. ASTM Designation: E950, “Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference”, ASTM, 2009

ACKNOWLEDGEMENTS

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APPENDIX A

Table A-1 - Asphalt Concrete Pavement Distress Evaluation Summary

Distress Type	Transverse Cracking	Longitudinal Cracking – Non-Wheel Path	Longitudinal Lane Joint Cracking	Alligator Cracking	Patching	Delamination	Bleeding	Rutting	Raveling
Description	Cracks running transverse (across) to the Centerline of the road	Cracks running parallel to the Centerline of the road – Cracks in wheelpaths count as low severity alligator cracking	Paving joints. Only classified as a distress if the joint has cracked and will allow water penetration.	One longitudinal crack in the wheel path, or Interconnected cracks having a chicken wire or "alligator hide pattern"	Areas of pavement replaced, or Areas of pavement covered with new material	Surface lost due to lack of adhesion to lower layers	Excess asphalt cement, **or** Surface appears shiny or glassy	Longitudinal surface depression in the wheel path	Wearing away of the pavement surface caused by the dislodging of aggregate particles or loss of asphalt binder
Low Severity	Well sealed with width indeterminate **or** Unsealed but closed	Well sealed with width indeterminate **or** Unsealed but closed	Sealed joint such that width cannot be determined **or** Open joint	Single long. Crack in WP **or** Few interconnecting cracks with no spalling	N/A	N/A	Surface discolored by excess AC	Ave depth equal to or greater than 0.25" but less than 0.5"	Minimal aggregate loss; Small amounts of stripping may be detected; Aggregate has started to wear away.
Moderate Severity	Open, unsealed crack 1/4" to 1/2" in width **or** Crack with adjacent random cracking. Block may be present	N/A	N/A	Alligator pattern with no more than slight spalling. Cracks typically 1/4" wide	N/A	NA	N/A	Ave depth equal to or greater than 0.5" but less than 1.0"	Some stripping evident; Small areas (less than one square foot) or strips of aggregate broken away.
High Severity	Open, unsealed crack > 1/2" in width **or** Crack with adjacent random cracking. Frequent blocking likely	Open, unsealed crack **or** Any crack with adjacent random cracking	Joint cracked with severe spalling or adjacent cracking.	Alligator pattern with moderate or severe spalling. Cracks typically > 3/8" wide	N/A	NA	Shiny appearance; Possible tire marks	Ave depth equal to or greater than 1.0"	Stripping very evident; Aggregate accumulation; Large sections (greater than one square foot) of stripping with aggregate layer broken away.
Counting	Linear Feet	Linear Feet	Linear Feet	Square Feet	Square ft. of Wheel and Non Wheel Path	Square ft.	Square ft.	Average rut depth per 0.1 mile	Average rut depth per 0.1 mile
Notes				Count worst severity level	Not counted if long dim not > than 6 inches	Not counted if long dim not > than 6 inches		Collect using automated systems	Collect using automated systems

Table A-2 - Additional Distress Evaluation for Asphalt Concrete Overlays of PCC Pavements

Distress Type	Reflection Cracking of Transverse Joints	Reflection Cracking of Longitudinal Joints	**All Other Distresses** (same as for Asphalt Concrete pavement)
Description	Relatively straight Transverse cracks directly over joints in underlying PCC pavement	Relatively straight longitudinal cracks directly over joints in underlying PCC pavement	Same as those for Asphalt Concrete Pavement - See Chapter 2 and/or Table 1
Low Severity	Well sealed crack with crack width indeterminate **or** A closed unsealed crack	Well sealed crack with crack width indeterminate **or** A closed unsealed crack	NA
Moderate Severity	A crack with width more than or equal to ¼ inches but less than ¾ inches **or** A crack with width less than ¾ inches and with adjacent (within 1 foot) random cracking One low or moderate severity crack with an adjacent (within 1 foot) low severity crack is rated as one crack of moderate severity	A crack with width more than or equal to ¼ inches but less than ¾ inches **or** A crack with width less than ¾ inches and with adjacent (within 1 foot) random cracking One low or moderate severity crack with an adjacent (within 1 foot) low severity crack is rated as one crack of moderate severity	NA
High Severity	A crack with width more than or equal to ¾ inches **or** A crack with width more than ¼ inches and with deterioration for a width greater than 6 inches. Two adjacent (within 1 foot) moderate or high severity cracks are rated as one high severity crack.	A crack with width more than or equal to ¾ inches **or** A crack with width more than ¼ inches and with deterioration for a width greater than 6 inches. Two adjacent (within 1 foot) moderate or high severity cracks are rated as one high severity crack.	NA
How to Count	Linear Feet	Linear Feet	NA
Notes	Only one reflective crack reported per underlying joint.	If in the wheel path, typically reported as low severity alligator	NA

Table A-3 - Jointed Portland Cement Concrete Pavement Distress Evaluation

Distress Type	Corner Breaks	**Joint Seal Condition** Transverse and Longitudinal	Joint Spalling: Transverse	Joint Spalling: Longitudinal	**Linear Cracking** Transverse and Longitudinal	Shattered Slabs	PCC Patching and Deterioration	Asphalt Patching
Description	A Corner Break is defined by an angled crack intercepting one side and one end of a slab.	Joints appearing unsealed or only partially sealed are considered to be unsealed.	Breaking or chipping of slab edges along a joint.	Breaking or chipping of slab edges along a joint.	Cracks running roughly parallel or transverse to the centerline of the road.	A slab broken into 4 or more pieces by cracking.	A portion > 1 sq. ft. of the slab has been removed and replaced or new material added.	A temporary repair of a severely distressed area with AC
Low Severity	Crack is spalled no more than 1/4 the crack length and the corner break is in one piece.	N/A	Spalls are less than 3 inches wide **or** Spalls with no loss of material or patching	N/A	A well-sealed, indeterminate width crack, **or** A closed crack with no spalling.	N/A	No distress in patch or surrounding area.	N/A
Moderate Severity	N/A	N/A	Spalls are 3 to 6 inches wide with loss of material. May be patched.	N/A	N/A	N/A	Low severity distress of any kind in patch or surrounding area.	N/A
High Severity	Crack is spalled more than 1/4 the crack length, **or** The corner break is in two or more pieces.	N/A	Spalls are greater than 6 inches wide with loss of material. May be patched.	N/A	Any open crack **or** Any spalled crack	N/A	Moderate or high severity distress of any kind in patch or surrounding area.	N/A
How to Count	Count number of slabs with corner breaks.	Trans. Joint Seal – No. Jts Fully Sealed Long. Joints – No. of Slabs with Fully Sealed Long.Joints.	No. of slabs at each severity.	No. of slabs with longitudinal joint spalling.	Count number of slabs with cracking greater than 1-ft. long. Count highest severity level present in slab.	Count the number of divided slabs in the section.	Count the number of slabs with PCC patching. Count the highest severity found.	Count the number of slabs with Asphalt Patches.
Notes	If more than 1 severity, count highest severity present in slab.	Joints must be sealed for at least 90% of their length to be fully sealed.	Report as highest severity level present		Slabs broken into 4 or more pieces are defined as divided slabs.	When a slab is divided no other distress is counted.	Patches with a longest dimension of less than 6 inches are not counted.	Patches with a longest dimension of less than 6 inches are not counted.

Table A-4 - Continuously Reinforced Concrete Pavement Distress Evaluation

Distress Type	Transverse Cracks	Clustered Cracking	Punchouts and Spalled "Y" Cracks	PCC Patching and Deterioration	Asphalt Patching	Longitudinal Cracks	Longitudinal Joint Spalling	Longitudinal Joint Seal Condition
Description	Cracks roughly transverse to the pavement centerline.	A group of three or more transverse cracks with average spacing of 2 feet or less.	Slab broken by 2 or more cracks **or** Spalled "Y" cracks.	A portion > 1 sq. ft. of the slab has been removed and replaced.	A temporary repair of a severely distressed area with AC	Cracks roughly parallel to the pavement centerline.	Breaking or chipping of slab edges along and within 1 ft. of a longitudinal joint.	A sealed joint is one that appears from the image to be capable of resisting the infiltration of surface water.
Low Severity	A closed transverse crack with no spalling.	Average crack spacing between 1 and 2 feet	N/A	No distress in patch or surrounding area.	N/A	A longitudinal crack with no spalling.	N/A	N/A
Moderate Severity	An open (>1/4") transverse crack with no spalling.	N/A	N/A	Patch or surrounding area has some CRCP low severity distress.	N/A	A longitudinal crack with spalling equal to or less than 1/4 of the crack length.	N/A	N/A
High Severity	Any transverse crack with spalling.	Average crack spacing less than 1 foot	N/A	Patch or surrounding area has some CRCP moderate or greater severity distress.	N/A	A longitudinal crack with spalling greater than 1/4 of the crack length.	NA	NA
How to Count	Number and length of cracks for each severity level.	Count number of occurrences and Sq. Ft. by severity level.	Count number of occurrences and Square Feet.	Count the Square Feet of patching by severity level and the number of patches by severity.	Count the Square Feet of patching by severity level and the number of asphalt patches.	Linear ft. of cracks for each severity level.	Record the linear feet of joint spalling.	Record linear feet of pavement/shoulder joint fully sealed. If greater than 90% then the joint is considered seal and "Y" should be recorded.
Notes	Average transverse crack spacing needed (section length/total number of cracks)	Clustered cracks are not included as transverse cracks.		Patches with a longest dimension of less than 6 inches are not counted.	Patches with a longest dimension of less than 6 inches are not counted.	Minimum crack length is 1 foot before reporting.	Record linear feet of pavement/shoulder joint fully sealed.	

Table A-5 - Left and Right Shoulder Distress Evaluation

Distress Type	Shoulder Type	Shoulder Width	Shoulder Condition	Deficient Slope	Build-up	Shoulder Drop-off	Travel Lane to Shoulder Drop-off
Description	Defined based on seven different categories: Curb, Gravel, Asphalt, Concrete, Paved Combination, Unpaved Combination or None	Estimate the width of each type of material classified.	The condition of the shoulder material is reported. Report for each shoulder type recorded.	A shoulder slope that does not drain water away from the pavement.	Vegetation growth or debris build-up that adversely affects drainage.	Difference in elevation between the traveled surface or paved shoulder and the earth or gravel shoulder.	Difference in elevation between the traveled surface and the paved shoulder
Low Severity	N/A	N/A	Cracks and break-up, if any, are very minor. There are no distortions (like pushing or shoving) in the shoulder.	N/A	N/A	N/A	N/A
Moderate Severty	N/A	N/A	Cracks and break-up could affect some of the shoulder area but do not affect more than 50% of the shoulder area. There could be some distortions.	N/A	N/A	N/A	N/A
High Severity	N/A	N/A	Cracks and break-up are significant and affect more than 50% of the shoulder area. The distortions affect a significant portion of the shoulder area that could create a safety hazard.	N/A	N/A	N/A	N/A
How to Count	Report up to two shoulder types per side.	Report as follows: 0 to 1’ report as 2’ 1 to 3’ report as 2’ 3 to 6’ report as 4’ 6 to 9’ report as 8’ > 9’ report as 12’	Linear feet for each condition.	Linear feet of shoulder with deficient slope.	Linear feet of build-up.	Linear feet of shoulder with a drop-off >= 2 inches.	Linear feet of shoulder with a drop-off >= 0.5 inches.
Notes		Report for up to two types of shoulder on each side of roadway					

APPENDIX B

Glossary of Terms

Asphalt Concrete Pavement: A flexible pavement with a hot mixed asphalt concrete surface. In the context of this manual, chip seals are also included.

Composite Pavement: A pavement comprised of both rigid and flexible layers, usually with a Portland cement concrete (PCC) base covered by an asphalt concrete surface layer(s).

CRC (Continuously Reinforced Concrete Pavement): A Portland cement concrete pavement with no transverse joints and with heavy amounts of longitudinal steel to hold shrinkage cracks tightly closed.

Flexible Pavement: A pavement comprised of bituminous bound layers, unbound aggregate layer, or a combination of the two.

JCP (Jointed Concrete Pavement): A Portland cement concrete pavement with transverse joints to control natural shrinkage. Jointed plain concrete pavements (JPCP) have relatively short slabs (20' or less) to minimize shrinkage cracking and no distributed steel. Jointed reinforced concrete pavements (JRCP) have relatively long slabs (over 20') and contain distributed steel so that shrinkage cracks are held tightly closed.

Longitudinal: A direction running predominately with (parallel to) the direction of travel. Used to describe pavement features as with longitudinal cracking or longitudinal joints.

Longitudinal Construction Joint: A paving discontinuity created by the intersection of paving passes.

Pavement Distresses: Various distresses found on each of the pavement types are fully described and defined throughout this document. In general those distresses will characterized by type of distress, severity of distress, and the extent of distress.

Rigid Pavement: A pavement comprised of a Portland cement concrete (PCC) surface course.

Surface Treatment Pavement: A pavement structure comprised of layers bound by liquid bitumen but having no hot mixed materials.

Transverse: A direction running predominately across (perpendicular to) the direction of travel. Used to describe pavement features as with transverse cracking or transverse joints.

Wheel Path: The wheel path is a line or path followed by the tire of a road vehicle on a traveled surface. For pavement evaluation purposes each lane has two wheel paths parallel to the direction of travel.

APPENDIX C – Data Delivery Table Formats

Table C-1 - Asphalt Concrete Pavement Deliverable Table

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Pavement Management System Location ID	PMS_LOC_IDENT	ALL		*	N	*	0
Eight Digit Route Number	ROUTE1	ALL		xxxxxxxx	C	8	0
Date Tested	EFF_DATE	ALL		DDMMYYYY	D	8	
Year	EFF_YEAR	ALL	Year	9999	N	4	0
County	COUNTY	ALL		999	N	3	0
Number of Lanes	NUMBER_OF_LANES	ALL		9	N	1	0
Cardinal Direction	NC_DRCTN_CD	ALL	N,S,E,W,I,O,B	x	C	1	0
PMS Direction	DRCTN_CLCTD_CD	ALL	I, D	x	C	1	0
Begin Milepost	OFFSET_FROM	ALL	Mile	999.999	N	7	3
End Milepost	OFFSET_TO	ALL	Mile	999.999	N	7	3
Length	LENGTH	ALL	Mile	999.999	N	7	3
Testing Speed	SPEED	ALL	MPH	99	N	2	0
IRI Left Wheelpath	LEFT_IRI	ALL	Inches/Mile	999	N	3	0
IRI Right Wheelpath	RIGHT_IRI	ALL	Inches/Mile	999	N	3	0
IRI Average	NC_IRI_L_R_AVG	ALL	Inches/Mile	999	N	3	0
Section Width	SEC_WIDTH	ALL	Feet	99	N	2	0
Transverse Cracking Low Severity	TRNSVRS_LOW_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Transverse Cracking Moderate Severity	TRNSVRS_MDRT_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Transverse Cracking High Severity	TRNSVRS_HGH_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Longitudinal Cracking Low Severity	LNGTDNL_LOW_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Longitudinal Cracking High Severity	LNGTDNL_HGH_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Longitudinal Lane Joint Low Severity	LNGTDNL_LANE_JNT_LOW_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Longitudinal Lane Joint High Severity	LNGTDNL_LANE_JNT_HGH_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Reflective Transverse Cracking Low Severity	RFLCT_TRNSVRS_LOW_LF	AC/COMPOSITE	Linear Feet	9999	N	4	0
Reflective Transverse Cracking Moderate Severity	REFLCT_TRNSVRS_MDRT_LF	AC/COMPOSITE	Linear Feet	9999	N	4	0
Reflective Transverse Cracking High Severity	REFLCT_TRNSVRS_HGH_LF	AC/COMPOSITE	Linear Feet	9999	N	4	0
Reflective Longitudinal Cracking Low Severity	REFLCT_LNGTDNL_LOW_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Reflective Longitudinal Cracking Moderate Severity	REFLCT_LNGTDNL_MDRT_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Reflective Longitudinal Cracking High Severity	REFLCT_LNGTDNL_HGH_LF	AC/COMPOSITE	Linear Feet	99999	N	5	0
Alligator Cracking Low Severity	ALGTR_LOW_SF	AC/COMPOSITE	Square Feet	99999	N	5	0
Alligator Cracking Moderate Severity	ALGTR_MDRT_SF	AC/COMPOSITE	Square Feet	99999	N	5	0
Alligator Cracking High Severity	ALGTR_HGH_SF	AC/COMPOSITE	Square Feet	99999	N	5	0
Ravelling Low Severity	RVL_LOW_SF	AC/COMPOSITE	Square Feet	99999	N	5	0
Ravelling Moderate Severity	RVL_MDRT_SF	AC/COMPOSITE	Square Feet	99999	N	5	0
Ravelling High Severity	RVL_HGH_SF	AC/COMPOSITE	Square Feet	99999	N	5	0

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Patching Area - wheel path	WP_PTCH_SF	AC/COMPOSITE	Square Feet	999999	N	6	0
Patching Area - Non wheel path	NWP_PTCH_SF	AC/COMPOSITE	Square Feet	999999	N	6	0
Delaminations Area	DLMN_SF	AC/COMPOSITE	Square Feet	9999	N	5	0
Bleeding Low Severity	BLD_LOW_SF	AC/COMPOSITE	Square Feet	9999	N	5	0
Bleeding High Severity	BLD_HGH_SF	AC/COMPOSITE	Square Feet	9999	N	5	0
Maximum Average Rut Depth	MAX_RUT_AVG	AC/COMPOSITE	Inch	9.99	N	5	2
Pavement Type	NC_PVMT_CD_ID	AC/COMPOSITE		xxx	C	3	
Filename	FILENAME	ALL		xxxxxxxx	C	8	
Start GPS Latitude	LAT_FROM	ALL		100	N	15	10
Start GPS Longitude	LONG_FROM	ALL		1000	N	15	10
End GPS Latitude	LAT_TO	ALL		100	N	15	10
End GPS Longitude	LONG_TO	ALL		1000	N	15	10

Table C-2 - Jointed Concrete Deliverable Table

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Pavement Management System Location ID	PMS_LOC_IDENT	ALL		*	N	*	0
Eight Digit Route Number	ROUTE1	ALL		xxxxxxxx	C	8	
Date Tested	EFF_DATE	ALL		DDMMYYYY	D	8	
Year	EFF_YEAR	ALL	Year	9999	N	4	0
County	COUNTY	ALL		999	N	3	0
Number of Lanes	NUMBER_OF_LANES	ALL		9	N	1	0
Cardinal Direction	NC_DRCTN_CD	ALL	N,S,E,W,I,O,B	x	C	1	0
Direction Collected (Increasing/Decreasing)	DRCTN_CLCTD_CD	ALL	I, D	x	C	1	0
Begin Milepost	OFFSET_FROM	ALL	Mile	999.999	N	7	3
End Milepost	OFFSET_TO	ALL	Mile	999.999	N	7	3
Length	LENGTH	ALL	Mile	999.999	N	7	3
Testing Speed	SPEED	ALL	MPH	99	N	2	0
IRI Left Wheelpath	LEFT_IRI	ALL	Inches/Mile	999	N	3	0
IRI Right Wheelpath	RIGHT_IRI	ALL	Inches/Mile	999	N	3	0
IRI Average	NC_IRI_L_R_AVG	ALL	Inches/Mile	999	N	3	0
Section Width	SEC_WIDTH	ALL	Feet	99	N	2	0
Transverse Cracking Low Severity	TRNSVRS_CRK_LOW_NBR	JCP	# of Slabs	9999	N	4	0
Transverse Cracking High Severity	TRNSVRS_CRK_HGH_NBR	JCP	# of Slabs	9999	N	4	0
Longitudinal Cracking Low Severity	LNGTDNL_CRK_LOW_NBR	JCP	# of Slabs	9999	N	4	0
Longitudinal Cracking High Severity	LNGTDNL_CRK_HGH_NBR	JCP	# of Slabs	9999	N	4	0
PCC Patch Low Severity	CON_PTCH_LOW_NBR	JCP	# of Slabs	9999	N	4	0
PCC Patch Moderate Severity	CON_PTCH_MDRT_NBR	JCP	# of Slabs	9999	N	4	0
PCC Patch High Severity	CON_PTCH_HGH_NBR	JCP	# of Slabs	9999	N	4	0
Asphalt Patch Count	ASPHLT_PTCH_NBR	JCP	# of Slabs	9999	N	4	0
Number of Transverse Joints	TRNSVRS_JNT_NBR	JCP	Count	999	N	3	0
Joint Spacing	JNT_SPCG_NBR	JCP	Feet	999	N	2	0
Transverse Joint Spalled Low Severity	TRNSVRS_SPLL_LOW_NBR	JCP	# of Slabs	9999	N	4	0
Transverse Joint Spalled Moderate Severity	TRNSVRS_SPLL_MDRT_NBR	JCP	# of Slabs	9999	N	4	0
Transverse Joint Spalled High Severity	TRNSVRS_SPLL_HGH_NBR	JCP	# of Slabs	9999	N	4	0
Transverse Joint Fully Sealed	TRNSVRS_JNT_SEAL_NBR	JCP	# of Joints	9999	N	4	0
Longitudinal Joint Spalled	LNGTDNL_JNT_SPLL_NBR	JCP	# of Slabs	9999	N	4	0
Longitudinal Joint Fully Sealed	LNGTDNL_JNT_SEAL_NBR	JCP	# of Slabs	9999	N	4	0
Corner Breaks Low Severity	CRNR_LOW_NBR	JCP	# of Slabs	9999	N	4	0
Corner Breaks High Severity	CRNR_HGH_NBR	JCP	# of Slabs	9999	N	4	0
Shattered Slabs	SHTRD_SLAB_NBR	JCP	# of Slabs	9999	N	4	0

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Joint Fault None	FAULT_NONE_NBR	JCP	# of Joints	999	N	3	0
Joint Fault Low Severity	FAULT_LOW_NBR	JCP	# of Joints	999	N	3	0
Joint Fault Moderate Severity	FAULT_MDRT_NBR	JCP	# of Joints	999	N	3	0
Joint Fault High Severity	FAULT_HGH_NBR	JCP	# of Joints	999.9	N	5	1
Average Joint Fault	FAULT_AVG	JCP	Inch	9.99	N	5	2
Filename	FILENAME	ALL		xxxxxxxx	C	8	
Start GPS Latitude	LAT_FROM	ALL		100	N	15	10
Start GPS Longitude	LONG_FROM	ALL		1000	N	15	10
End GPS Latitude	LAT_TO	ALL		100	N	15	10
End GPS Longitude	LONG_TO	ALL		1000	N	15	10

Table C-3 - CRC Deliverable Table

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Pavement Management System Location ID	PMS_LOC_IDENT	ALL		*	N	*	0
Eight Digit Route Number	ROUTE1	ALL		xxxxxxxx	C	8	
Date Tested	EFF_DATE	ALL		DDMMYYYY	D	8	
Year	EFF_YEAR	ALL	Year	9999	N	4	0
County	COUNTY	ALL		999	N	3	0
Number of Lanes	NUMBER_OF_LANES	ALL		9	N	1	0
Cardinal Direction	NC_DRCTN_CD	ALL	N,S,E,W,I,O,B	x	C	1	0
Direction Collected (Increasing/Decreasing)	DRCTN_CLCTD_CD	ALL	I, D	x	C	1	0
Begin Milepost	OFFSET_FROM	ALL	Mile	999.999	N	7	3
End Milepost	OFFSET_TO	ALL	Mile	999.999	N	7	3
Length	LENGTH	ALL	Mile	999.999	N	7	3
Testing Speed	SPEED	ALL	MPH	99	N	2	0
IRI Left Wheelpath	LEFT_IRI	ALL	Inches/Mile	999	N	3	0
IRI Right Wheelpath	RIGHT_IRI	ALL	Inches/Mile	999	N	3	0
IRI Average	NC_IRI_L_R_AVG	ALL	Inches/Mile	999	N	3	0
Section Width	SEC_WIDTH	ALL	Feet	99	N	2	0
Transverse Cracking Low Severity	TRNSVRS_CRK_LOW_LF	CRC	Linear Feet	99999	N	5	0
Transverse Cracking Moderate Severity	TRNSVRS_CRK_MDRT_LF	CRC	Linear Feet	99999	N	5	0
Transverse Cracking High Severity	TRNSVRS_CRK_HGH_LF	CRC	Linear Feet	99999	N	5	0
Transverse Cracking Total Number	TRNSVRS_CRK_NBR	CRC	Count	999	N	3	0
Transverse Crack Average Spacing	TRNSVRS_CRK_AVG_SPC	CRC	Linear Feet	999.9	N	5	1
Longitudinal Cracking Low Severity	LNGTDNL_CRK_LOW_LF	CRC	Linear Feet	9999	N	4	0
Longitudinal Cracking Moderate Severity	LNGTDNL_CRK_MDRT_LF	CRC	Linear Feet	9999	N	4	0
Longitudinal Cracking High Severity	LNGTDNL_CRK_HGH_LF	CRC	Linear Feet	9999	N	4	0
Clustered Cracking Low Severity	CLSTR_LOW_NBR	CRC	Count	9999	N	4	0
Clustered Cracking High Severity	CLSTR_HGH_NBR	CRC	Count	9999	N	4	0
Clustered Cracking Low Severity	CLSTR_LOW_SF	CRC	Square Feet	9999	N	4	0
Clustered Cracking High Severity	CLSTR_HGH_SF	CRC	Square Feet	9999	N	4	0
Longitudinal Joint Spalling	LNGTDNL_SPLL_LF	CRC	Linear Feet	9999	N	4	0
Longitudinal Joint Fully (90%) Sealed	LNGTDNL_SEAL	CRC	Yes/No	x	C	1	
Punchouts and Spalled Ycracks	PNCH_NBR	CRC	Count	999	N	3	0
Punchouts and Spalled Ycracks	PNCH_SF	CRC	Square Feet	9999	N	4	0
PCC Patch Low Severity	CON_PTCH_LOW_SF	CRC	Square Feet	9999	N	4	0
PCC Patch Moderate Severity	CON_PTCH_MDRT_SF	CRC	Square Feet	9999	N	4	0
PCC Patch High Severity	CON_PTCH_HGH_SF	CRC	Square Feet	9999	N	4	0

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Asphalt Patch Area	ASPHLT_PTCH_SF	CRC	Square Feet	9999	N	4	0
PCC Patch Low Severity	CON_PTCH_LOW_NBR	CRC	Count	999	N	3	0
PCC Patch Moderate Severity	CON_PTCH_MDRT_NBR	CRC	Count	999	N	3	0
PCC Patch High Severity	CON_PTCH_HGH_NBR	CRC	Count	999	N	3	0
Asphalt Patch Count	ASPHLT_PTCH_NBR	CRC	Count	999	N	3	0
Filename	FILENAME	ALL		xxxxxxxx	C	8	
Start GPS Latitude	LAT_FROM	ALL		100	N	15	10
Start GPS Longitude	LONG_FROM	ALL		1000	N	15	10
End GPS Latitude	LAT_TO	ALL		100	N	15	10
End GPS Longitude	LONG_TO	ALL		1000	N	15	10

Table C-4 - Shoulder Deliverable Table

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Pavement Management System Location ID	PMS_LOC_IDENT	ALL		*	N	*	0
Route ID	ROUTE1	ALL		xxxxxxxx	C	8	
Date Tested	EFF_DATE	ALL		YYYYMMDD	C	8	
Year	EFF_YEAR	ALL	Year	9999	N	4	0
County	COUNTY	ALL		9	N	3	
Number of Lanes	NUMBER_OF_LANES	ALL		9	N	1	
Survey Direction	NC_DRCTN_CD	ALL		x	C	1	
Direction Collected (Increasing/Decreasing)	DRCTN_CLCTD_CD	ALL	I, D	x	C	1	0
Begin Milepost	OFFSET_FROM	ALL	Mile	999.999	N	7	3
End Milepost	OFFSET_TO	ALL	Mile	999.999	N	7	3
Length	LENGTH	ALL	Mile	999.999	N	7	3
Speed	SPEED	ALL	mph	99	N	2	
Shoulder Type Right 1	SHLDR_TYPE_R1	ALL		xxx	C	3	
Shoulder Type Right 2	SHLDR_TYPE_R2	ALL		xxx	C	3	
Shoulder Length Right 1	SHLDR_LENGTH_R1_FT	ALL	Feet	9999.99	N	7	2
Shoulder Length Right 2	SHLDR_LENGTH_R2_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 1: None	SHLDR_R1_NONE_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 2: None	SHLDR_R2_NONE_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 1: Low Severity	SHLDR_R1_LOW_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 2: Low Severity	SHLDR_R2_LOW_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 1: Moderate Severity	SHLDR_R1_MDRT_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 2: Moderate Severity	SHLDR_R2_MDRT_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 1: High Severity	SHLDR_R1_HGH_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Right 2: High Severity	SHLDR_R2_HGH_FT	ALL	Feet	9999.99	N	7	2
Shoulder width - Right 1	SHLDR_WIDTH_R1_AVG	ALL	Average	999.9	N	5	1
Shoulder width - Right 2	SHLDR_WIDTH_R2_AVG	ALL	Average	999.9	N	5	1
Deficient Slope - Right	DEFCNT_SLOP_R_FT	ALL	Feet	9999.99	N	7	2
Shoulder Build-up - Right	SHLDR_BUILD_UP_R_FT	ALL	Feet	9999.99	N	7	2
Shoulder Drop_off - Right	SHLDR_DROP_OFF_R_FT	ALL	Feet	9999.99	N	7	2
Shoulder Type Left 1	SHLDR_TYPE_L1	ALL		xxx	C	3	
Shoulder Type Left 2	SHLDR_TYPE_L2	ALL		xxx	C	3	
Shoulder Length Left 1	SHLDR_LENGTH_L1_FT	ALL	Feet	9999.99	N	7	2
Shoulder Length Left 2	SHLDR_LENGTH_L2_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 1: None	SHLDR_L1_NONE_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 2: None	SHLDR_L2_NONE_FT	ALL	Feet	9999.99	N	7	2

Description	*Field Name*	*Pavement Type*	*Units*	*Format*	*Field Type*	*Field Width*	*Dec.*
Shoulder Condition Left 1: Low Severity	SHLDR_L1_LOW_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 2: Low Severity	SHLDR_L2_LOW_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 1: Moderate Severity	SHLDR_L1_MDLT_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 2: Moderate Severity	SHLDR_L2_MDLT_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 1: High Severity	SHLDR_L1_HGH_FT	ALL	Feet	9999.99	N	7	2
Shoulder Condition Left 2: High Severity	SHLDR_L2_HGH_FT	ALL	Feet	9999.99	N	7	2
Shoulder width - Left 1	SHLDR_WIDTH_L1_AVG	ALL	Average	999.9	N	5	1
Shoulder width - Left 2	SHLDR_WIDTH_L2_AVG	ALL	Average	999.9	N	5	1
Deficient Slope - Left	DEFCNT_SLOP_L_FT	ALL	Feet	9999.99	N	7	2
Shoulder Build-up - Left	SHLDR_BUILD_UP_L_FT	ALL	Feet	9999.99	N	7	2
Shoulder Drop_off - Left	SHLDR_DROP_OFF_L_FT	ALL	Feet	9999.99	N	7	2
Filename	FILENAME	ALL		xxxxxxxx	C	8	
Start GPS Latitude	LAT_FROM	ALL		100	N	15	10
Start GPS Longitude	LONG_FROM	ALL		1000	N	15	10
End GPS Latitude	LAT_TO	ALL		100	N	15	10
End GPS Longitude	LONG_TO	ALL		1000	N	15	10

Appendix D – NCDOT Linear Referencing Guidelines

D.1 Divided Route Mileposting Rules

A substantial change was made to mileposting for the 2008 Pavement Condition Survey. To better match the mileposting system maintained by the NCDOT Geographic Information Systems Unit (NCDOT GIS), the mileposting methodology for divided highways has changed.

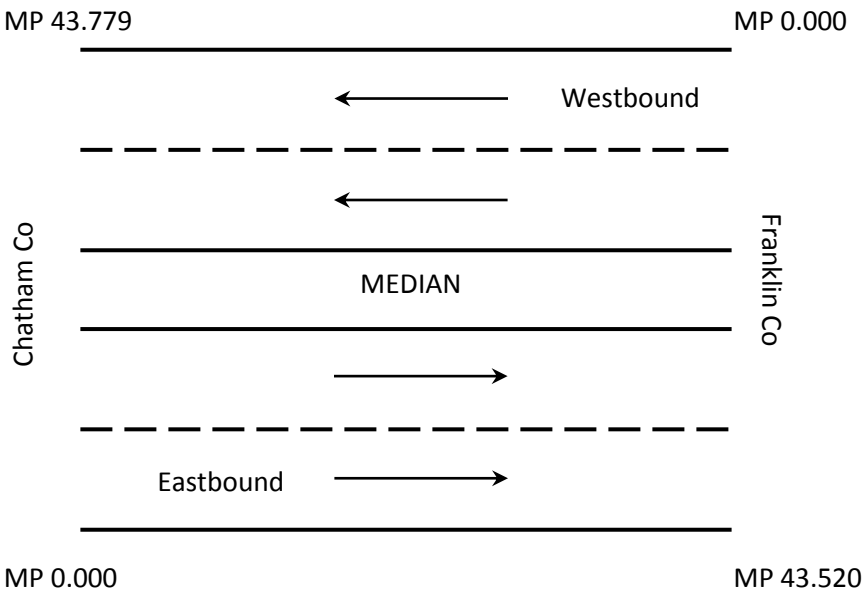
Divided highway mileposting is *reversed* in the non-primary direction. This effectively means that westbound and southbound routes count up from zero beginning at their entry point in the county or other starting point.

NCDOT GIS is in the process of increasing the precision of the mileposting by adding more decimal places. In the past, mileposting precision was two decimal places (0.00). Now the mileposting precision for most routes is three decimal places (0.000).

An example of what this means for a divided route would be US 64 in Wake County. The *eastbound* (primary) direction has a milepost value of 0.000 at the *Chatham* County line. The *westbound* (secondary) direction has a milepost value of 0.000 at the *Franklin* County line.

Note that there may be small discrepancies in the total length of a route. In the case of US 64, the eastbound portion has a total length of 43.520 while the westbound has a length of 43.779. This is normal and is due to variation in roadway elevation and curvature.

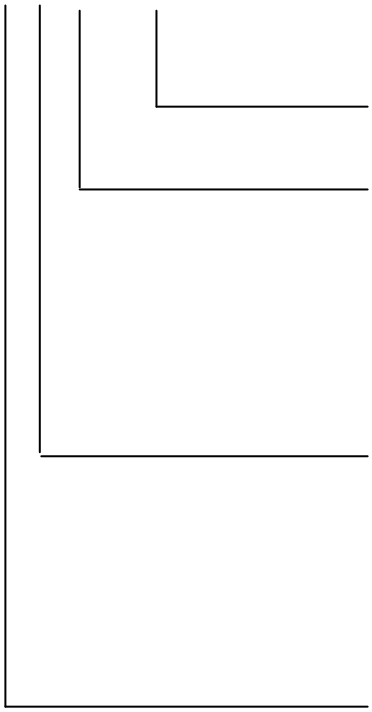
Divided Highway Mileposting Example



D.2 NCDOT Eight Digit Route Numbering

NCDOT uses an eight digit route number to designate highways and ramps. This number contains several pieces of information as shown below.

8 Digit Route #: X X X XXXXX



Route Number

Directional Code
- 0 = Primary
- 4 = Southbound
- 6 = Westbound
- 8 = Inner Loop
- 9 = Outer loop

Special Route Code*
- 1 = Alternate
- 2 = ByPass
- 7 = Spur
- 8 = Truck
- 9 = Business

Type of Route
- 1 = Interstate
- 2 = US
- 3 = NC
- 4 = SR

***Note** – US 19 in Yancey and Avery Counties is a special case of the Special Route Code. The highway is split into widely separated east and west sections and thus is labeled 25000019 or 26000019.

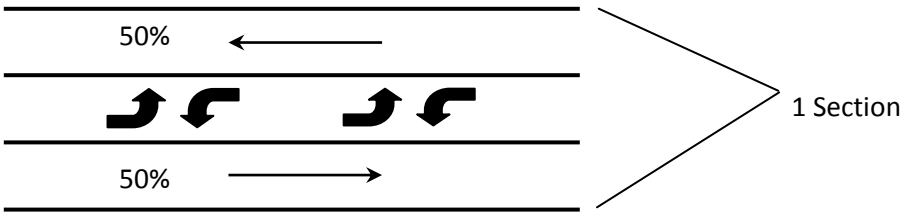
On divided ***primary*** highways, northbound or eastbound legs will have a value of 0 in the directional code slot (as they are the primary directions). The southbound and westbound directions will be coded with values of 4 and 6, respectively.

Divided ***secondary*** roads will have a 0 in the directional code slot in one direction and will always have a numeric value of 4 to indicate the opposing direction. This is due to secondary roads not having a default primary direction.

D.3 Data Collection Instructions for Multi-Lane Sections

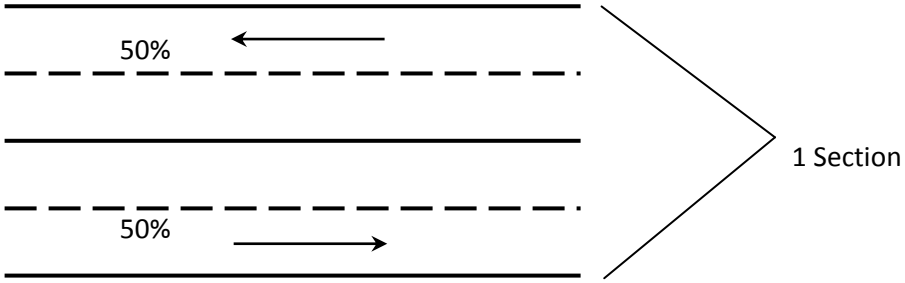
1. For multi-lane *undivided* highways (3 or more lanes), the rater shall evaluate the most distressed lane, generally the outside lane, in each direction. Each direction of travel (each lane) shall total 50 % of the section. *You will not rate all lanes, as in past surveys.*

3 Lanes with Middle Turn Lane



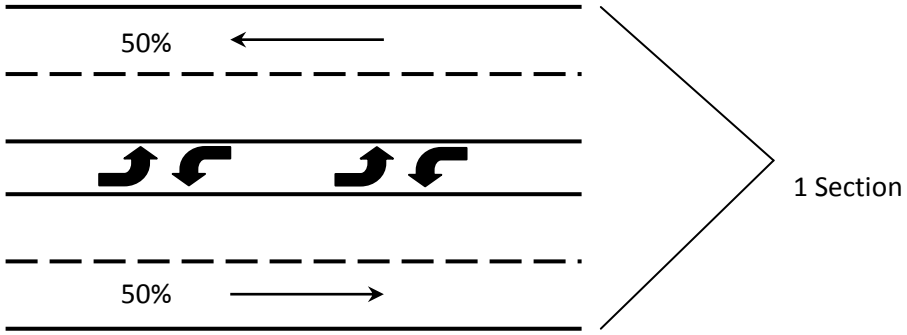
Rate through lanes together as one section. Do not rate turn lane.

4 Lane Undivided Highway



Rate both outside lanes in each direction together as one section.

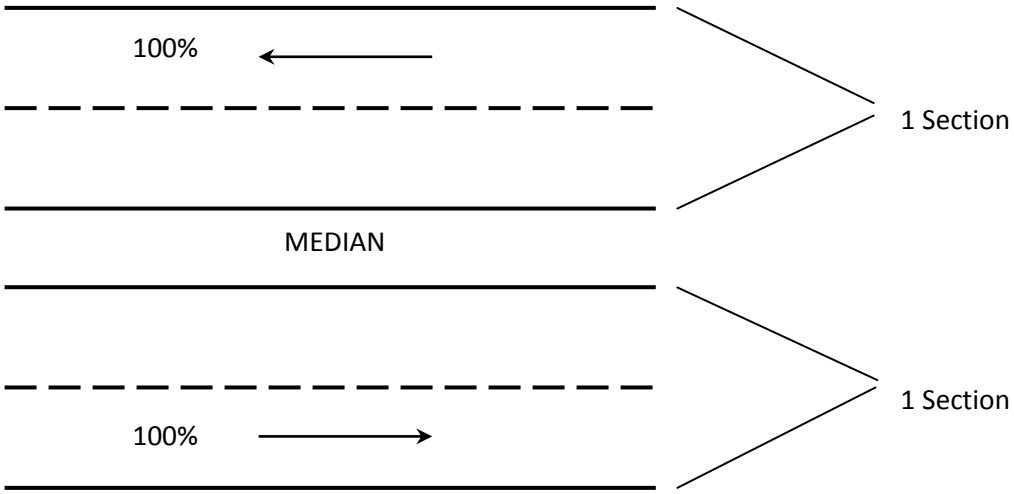
Multi-lane Undivided Highway with Turning Lane



Rate both outside lanes in each direction together as one section.

2. For *divided* highways, each direction of travel shall be rated as a separate section. The rater shall evaluate the most distressed lane, generally the outside lane, in each direction. Each direction of travel (each lane) shall total 100% of the section.

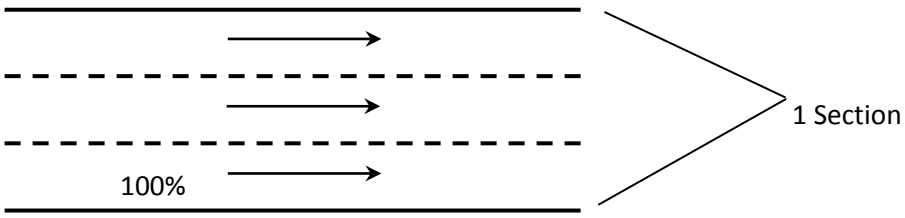
4 Lane Divided Highway



Rate outside lane in each direction as one section.

3. The rater will rate the outside lane or the most distressed lane in urban areas.

One-way Streets



Rate outside lane only as one section.

4. When conducting the Condition Survey on multilane highways, the condition of lanes in opposite directions of travel may not have the same rating. For example, there may be transverse cracking in one direction and no cracking at all in the other direction.

5. For multi-lane highways, the ADT for *each* direction shall be the total (two-way) ADT for the highway.

6. *Short Distance Interchange Widening:* There are instances where a two-lane primary route will split and become a four-lane divided facility at an interchange. For these cases, unless the divided section is *at least 0.50 miles long*, it shall be treated like a two-lane highway with only the outside lane in each direction being rated. For this case only, any paved shoulder would be ignored. If it is *equal to or longer than 0.50 miles,* then a new section shall be written up.

7. Interchange ramps are *not* to be rated.

D-4 North Carolina County List

County	County Number	County	County Number	County	County Number
Alamance	1	Franklin	35	Orange	68
Alexander	2	Gaston	36	Pamlico	69
Alleghany	3	Gates	37	Pasquotank	70
Anson	4	Graham	38	Pender	71
Ashe	5	Granville	39	Perquimans	72
Avery	6	Greene	40	Person	73
Beaufort	7	Guilford	41	Pitt	74
Bertie	8	Halifax	42	Polk	75
Bladen	9	Harnett	43	Randolph	76
Brunswick	10	Haywood	44	Richmond	77
Buncombe	11	Henderson	45	Robeson	78
Burke	12	Hertford	46	Rockingham	79
Cabarrus	13	Hoke	47	Rowan	80
Caldwell	14	Hyde	48	Rutherford	81
Camden	15	Iredell	49	Sampson	82
Carteret	16	Jackson	50	Scotland	83
Caswell	17	Johnston	51	Stanly	84
Catawba	18	Jones	52	Stokes	85
Chatham	19	Lee	53	Surry	86
Cherokee	20	Lenoir	54	Swain	87
Chowan	21	Lincoln	55	Transylvania	88
Clay	22	Macon	56	Tyrrell	89
Cleveland	23	Madison	57	Union	90
Columbus	24	Martin	58	Vance	91
Craven	25	McDowell	59	Wake	92
Cumberland	26	Mecklenburg	60	Warren	93
Currituck	27	Mitchell	61	Washington	94
Dare	28	Montgomery	62	Watauga	95
Davidson	29	Moore	63	Wayne	96
Davie	30	Nash	64	Wilkes	97
Duplin	31	New Hanover	65	Wilson	98
Durham	32	Northampton	66	Yadkin	99
Edgecombe	33	Onslow	67	Yancey	100
Forsyth	34				